THE

AMERICAN NATURALIST.

Vol. xi. — MARCH, 1877. — No. 3.

A FEW WORDS ABOUT SCAVENGERS.

BY PROF. SANBORN TENNEY.

IN most if not in all human societies there are classes, or at least individuals, who gain their chief subsistence by using or removing what others have ignored or discarded. That is, there are classes, or individuals, whose principal function seems to be that of scavengers.

(Fig. 16.) HYENA (HYENA VULGARIS.)

But scavengers are not confined to the human race. It is well known that as a general rule animals seek for their food living organisms or organic products in a good state of preservation. But there are in many of the classes of animals some kinds which prefer, or seem to prefer, to feed upon dead or decaying organisms. That is, there are animals whose chief function seems to be that of scavengers. Of some of these I will briefly speak.

Prominent among the mammalian scavengers are the hyenas (Figure 16), the ugliest in their general appearance of all the

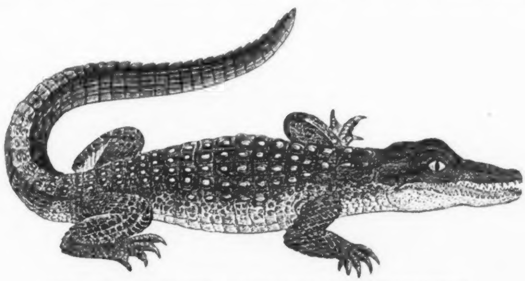
flesh eaters. These well-known animals are at present confined to the warm regions of Africa and Asia, where they feed upon animals which they find dead, and such parts of animals as have been left from the feasts of the lion, tiger, and others of the nobler kinds of the typical carnivora. The hyenas are about five feet in length, and are admirably fitted for their work as scavengers; for they not only devour the soft parts of animals, but their large, blunt premolar teeth and the powerful muscles

(FIG. 17.) CALIFORNIAN VULTURE (CATHARTES CALIFORNIANUS).

of their jaws enable them to crush and eat the bones of even very large animals; and thus these scavengers convert into their own living tissues not only parts, but the entire carcasses of animals that would otherwise taint the air and cause pestilence and death. This habit of the hyenas in preying upon dead animals is probably not one recently acquired. The members of this family that lived in Post-Tertiary times had essentially the same habits as have the hyenas of to-day, judging from their remains

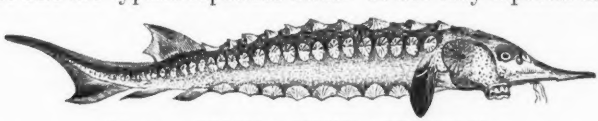
and other evidences found in the cave deposits in England and in many other parts of Europe.

If we study the birds we find among them, also, some kinds whose office is that of scavengers. Rather than pursue and capture living prey, these prefer to feed upon dead animals, and upon these they gorge themselves, often eating far more than they need; and thus they too convert noxious substances into their own tissues. Preëminent among the bird-scavengers are



(FIG. 18.) ALLIGATOR (ALLIGATOR MISSISSIPPIENSIS).

the vultures (Figure 17), including the condor and others, which of all the flesh-eating birds are the least adapted for capturing living prey, and which by their bare heads and bare necks are the best fitted for feeding upon carrion, which forms so large a part of their food. It should be added here, however, that while vultures as a family are true scavengers, there is at least one species, the famous lammergeyer of the Alps, which has habits more like the typical rapacious birds. It not only captures lambs



(FIG. 19.) STURGEON (ACIPENSER OXYRHYNCHUS).

and other animals, but has the reputation of sometimes carrying off an infant child.

Reptiles, too, furnish us with examples of scavengers. Although many turtles, and the alligators (Figure 18), crocodiles, and gavials, are exceedingly rapacious, they are also among the prominent scavengers, eagerly feeding upon the dead animals which they find in the streams which they inhabit.

Nor are fishes without a representation of scavengers. Some kinds, as certain of the sharks, combine the most rapacious with scavenger characteristics. The sturgeons (Figure 19) are gen-

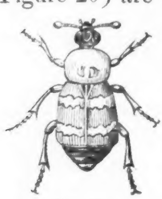
uine scavengers. With their long noses they turn up the bottoms of the streams and feed upon such organic materials as they chance to find, using perhaps the flexible feelers beneath the snout to search out the exact location and nature of the food.

The Catostomi, or "suckers," are essentially scavengers, although devouring also the weaker kinds of living animals. The same is true of the horn-pout and other species of cat-fish.

If we pass from the vertebrates to the articulates, we shall here find scavengers in every class. Among the insects, we may notice first the flies, some species of which are present to lay their eggs or deposit their larvæ in every animal as soon as it is dead. And how vast is the work which these little animals accomplish in transforming noxious substances into their own tissues. A single fly by means of her progeny can probably devour an ox quicker than can a hyena!

Mosquitoes in their larval state are also among the most important scavengers. They feed on the decaying organic substances which abound in the stagnant waters everywhere, and thus they help to remove the fruitful sources of malaria. Therefore we may put this fact down to their credit when we lie awake in the summer night, defending ourselves against the attacks of these pests in their adult state.

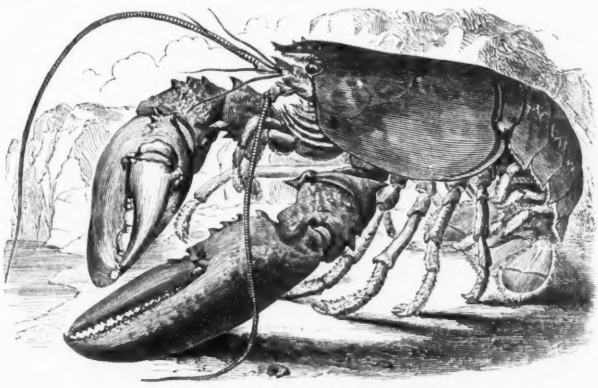
How many of the eighty or one hundred thousand species of beetles are scavengers, we may perhaps never know. But that there are many beetle scavengers we well know; and all are aware how constantly the common carrion beetles (*Silpha*, Figure 20) are engaged in the work so important to the higher animals and to man. No sooner is a dead animal thrown upon the ground and decay begins, than these beetles commence their work of rendering it harmless. Some species of carrion beetles have the habit of burying all the small animals which they find, — and they find out with astonishing quickness where such animals are. They bury animals by constantly digging beneath them; and when they have sunk them into the ground, out of sight, the females lay their eggs in them, so that when the young hatch they find themselves in the midst of suitable food.



(FIG. 20.)
CARRION BEETLE (SILPHA).

Among the Myriapods there are also some species which are scavengers. This is true of the well-known galley-worm (*Iulus*) found under rubbish and which quickly coils up when disturbed.

It is not pleasant for the epicure to learn that the lobster (Figure 21) is essentially a scavenger; but in a list of scavengers this and other crustaceans, notwithstanding their exhibition of true predaceous habits, cannot be omitted. They eagerly feed upon the dead organic materials which they find at the bottom of the ocean. The lobster fishermen well understand the scavenger habits of these crustaceans, and accordingly bait their lobster traps with pieces of fishes and of other animals, and then sink them to the bottom. What a wonderful chemistry these animals must possess to enable them to convert refuse animal matter into the delicious white muscle which most of us relish so much! And here it may be remarked that crustaceans are among the few scavengers whose flesh is prized for food by man.



(Fig. 21.) AMERICAN LOBSTER (HOMARUS AMERICANUS).

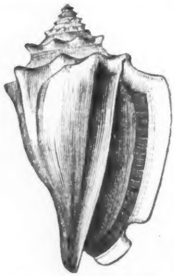
Most scavengers are of benefit to man only by aiding in keeping the air and the waters pure.

The mollusks have their scavengers. The strombs, whose heavy broad-lipped and deeply notched shells (Figure 22) are familiar objects in all of our museums, are prominent examples. The strombs are reckoned among the carnivorous gasteropods, but they are carnivorous in the same sense as are the vultures among birds, — they are carrion-eaters. And in this same category belong the slugs (*Limax*), and others.

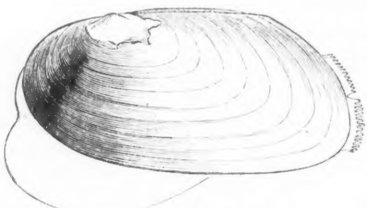
Clams, oysters, mussels, etc. (Figure 23), are to a certain extent scavengers. They feed upon whatever organic particles are brought to the mouth by the vibratile cilia of the gills. It is thus, in part, that these mollusks remove the fine particles from turbid and impure waters and ultimately render them clear.

I hasten to say, however, that bivalve mollusks do not feed wholly and probably not mainly on decaying organic particles. The currents of water, alluded to above, bear also all kinds of microscopic plants and animals which abound in the water where these bivalves live.

To what extent radiates and protozoans are represented by scavengers I am not now prepared to state, but reasoning from



(FIG. 22.) STROMB (STROMBUS PUGILIS).



(FIG. 23.) FRESH WATER MUSSEL (UNIO COMPLANATUS).

what we see in the other branches of the animal kingdom, we may at least suppose that there are true scavengers in these lowest branches also; and that their structure and appearance are perhaps as remarkable as are found in the higher forms.

And is there not something remarkable in the general appearance of scavengers as well as in their habits? Does not the hyena present a marked appearance among mammals, and the vulture among birds?

The facts about scavengers suggest many interesting questions. Why are there scavengers at all? Especially why are there scavengers in localities and regions where living animal food is apparently in great abundance? What is their origin? Have they existed from the beginning of animal life on the globe? When did the first individuals begin to appear in the various groups? Is their structure the result of their habits, or have their habits determined their structure?

The facts about scavengers are well known to all naturalists; and they are facts, without doubt, of deep significance. But I am not aware that the existence of scavengers has been explained in accordance with the modern views in biology.

It may possibly be replied that there is nothing specially remarkable in the existence of scavengers, when viewed in the light of the doctrines of natural selection. There is but little

doubt that the masters in modern biological thought have a ready answer to all or most of the questions which naturally arise in a thinking mind while considering the existence of scavengers among animals. Is not the subject worthy of their further attention, and may we not have the pleasure of reading their views in the Naturalist?

ON A PROVISIONAL HYPOTHESIS OF SALTATORY EVOLUTION.

BY W. H. DALL.

IT has long been brought forward, as against the Evolutionary Theory, that there were missing links in the chain of development which could not fairly be charged to the account of deficiencies in the palæontological record. This is the chief weapon of all opponents to the doctrines so generally received by modern naturalists. The number of instances in which the objection is well founded has been much exaggerated, but that there are cases of the kind will not, I think, be denied by any impartial student, though some imprudent partisans of the new faith have rather scoffed at the idea.

Having confidence that evolution when fully understood in all its modes will prove amply sufficient to account for all phases of organization, and realizing that leaps, gaps, saltations, or whatever they may be called, do occur, I have for some years made this branch of the subject a matter of reflection in the hope of arriving at some clew to the mode.

I have had my attention more especially called to the matter in studying a phase of the kind of evolution I have here termed *saltatory*, which is especially referred to in Cope's paper on the Origin of Genera, where, if I recollect rightly, it finds expression in the paradox that "the same species may belong to two different genera." [1] That is, more explicitly, that species which are abundantly proved to be distinct from each other by generic characteristics may be, so far as their specific characters are concerned, not distinguishable from one another. Such cases are mentioned by Cope in the paper alluded to, and there are other well-known instances of the paradox among birds, Crustacea, and Brachiopoda.

(1.) As an illustration of how the apparent leaps, which

[1] Not having seen Professor Cope's paper since about the time of its publication, and a copy not being accessible to me at this time, I may not have quoted the exact words, but the idea is the same.

nature occasionally exhibits, may still be perfectly in accordance with the view that all change is by minute differences gradually accumulated in response to the environment, I would offer the following example: —

In any sloping gutter of a paved street not too cleanly swept, every one will have noticed during a sudden shower how small particles of earth and other materials will sometimes act as a dam, producing a puddle which, relieved by partial drainage, may for a time appear to remain *in statu quo.* A time comes, however, when the gradually accumulated pressure suddenly sweeps the dam before it for a short distance. Then another similar pool is formed, and so on indefinitely.

(2.) The modern idea of a species may be stated to be *a greater or lesser number of similar individual organisms in which for the time being the majority of characters are in a condition of more or less stable equilibrium; and which have the power to transmit these characters to their progeny with a tendency to maintain this equilibrium.*

(3.) This tendency may be in some cases sufficiently strong to resist for a considerable period the changes which a gradual modification of the environment may tend to bring about. When the latter has reached a pitch which renders the resistance no longer effectual, it is conceivable that a sudden change may take place in the constitution of the organism, rapidly adapting it once more to its surroundings, upon which the tendency to equilibrium may reassert itself in the minor characteristics, and these may, as it were, crystallize once more in a manner not dissimilar in its results to the form which was recognizable in the earlier generic type.

(4.) If among a certain assemblage of individuals forming a species the tendency to maintain the specific equilibrium is (as it should be, *a priori*) transmitted to individual offspring in different degrees of intensity, a gradual separation may take place between those with the stronger tendency to equilibrium, and those with less.

(5.) Those yielding to the pressure of the environment (let us say in the manner indicated in paragraph 3) must by the law of natural selection become better adapted to it, and with their changed generic structure may be able to persist.

(6.) On the other hand, those with the broader base, so to speak, with an inherited tendency to remain unshaken by the modifications of the environment, may be conceived as being and

remaining, through this tendency, less injuriously affected by *adverse* circumstances and consequently might still endure.

(7.) In short, natural selection in the one case might find its fulcrum in the easy adjustment of characters; and in the other case in the inherited persistency in equilibrium, by which the organism would be rendered more or less indifferent to the injurious elements of the environment as well as to its favorable phases.

(8.) The intermediate individuals, by the hypothesis, would be those least fitted to persist in any case, and therefore would be few in number and rapidly eliminated. Then we should have a parallel series of species in two or even more genera, existing simultaneously.

(9.) The above hypothesis would account for the special class coming under the paradox quoted, and has an important bearing on the interpretation of certain embryological changes. For other forms of Saltatory Evolution attention should be directed to the inherited tendency to equilibrium which is the converse of the inherited tendency to vary, but which has hardly been granted the place in the history of evolution to which its importance entitles it. Mr. Darwin, whom nothing escapes, has apparently recognized it in his testimony to the "remarkably inflexible organization" of the goose. Other writers seem to have been chiefly attracted by the converse of this tendency, as, under the circumstances, is most natural.

It seems as if the preceding reasoning might serve as a key to many puzzling facts in nature, and perhaps deprive the catastrophists of their most serviceable weapon.

HINTS ON THE ORIGIN OF THE FLORA AND FAUNA OF THE FLORIDA KEYS.

BY L. F. DE POURTALES.

DURING several seasons passed on or near the Florida reefs and keys, engaged in sounding and dredging in the Gulf Stream, in the service of the United States Coast Survey, I had occasion to make a few observations on the vegetable and animal inhabitants of the islands. They were of course made without system, only in such places where the steamer happened to be in stormy weather, and I have been obliged to complete them as much as possible by the observations of others. Incomplete as they still are, they are given in the hope of drawing the atten-

tion of future visitors to this interesting region to several points in the mode of introduction of plants and animals into a new region, worthy of more extended study.

We have here a curious example, on a very small scale to be sure, of land of comparatively recent origin, which has received its flora and fauna from two different and very distinct sources, the West Indies and the North American Continent, and, as it seems, the flora chiefly from the former, the fauna mostly from the latter.

For a proper understanding of the subject I must refer to the description of the Florida keys and reefs, by Professor Agassiz, in the Coast Survey Report for 1851 (it was never published *in extenso*), and in his Methods of Study ; also to an able paper on the same subject, by the late Lieut. E. B. Hunt, of the United States Engineers, in the Coast Survey Report for 1862, and the *American Journal of Science*, vol. xxxv.

Lieutenant Hunt expresses the opinion that the reefs and keys shoot out as it were by their western end into the deep waters of the Gulf of Mexico. He says, "The well-traced curve along which this grand Florida bank thrusts itself out into the deep waters of the gulf is strikingly significant of some continuous and regular agency in its production. The adjacent flow of the Gulf Stream would most naturally be assumed to govern in some way the production of this curve. It however runs in the contrary direction to serve this explanatory use, and it is in fact rarely found to run close in upon the reef. There is, however, an eddy, countercurrent, intermitting in character and of variable rate, but on the whole a positive and prevailing current." We have not, unfortunately, observations enough of the currents near the reef to confirm these remarks otherwise than by a few scattered and often contrary ones, but judging by the effects, the above statement is undoubtedly true, and theoretically we should expect to find a countercurrent in the concave side of a bend of the main current. To the effect of this eddy ought to be added the still more regular westward action of the trade-wind and the flood tide. The formation of new islands and the westward extension of the reef are, however, probably of more than secular slowness, and the first discoverers of what was then called The Martyrs found them very nearly as we see them now. We may even have to record periods of retrogression as we do in glaciers, when a period of exceptionally frequent or violent hurricanes destroys more than the growth of corals and the piling up of their *débris* can supply.

Thus in the past forty years, Looe Key, part of Sand Key, and North Key, at the Tortugas, have been swept off and replaced by shoals.

The actual western termination of the system of keys is at Loggerhead Key, one of the Tortugas, but shoal ground extends some twenty miles farther west. The reef proper terminates opposite the Marquesas, about forty miles east of the Tortugas. The ancient reef which preceded the one which formed the keys did not extend as far west by more than one hundred miles, terminating about Cape Sable.[1]

The formation of the keys to the westward of Key West plainly shows their more recent origin. The Tortugas consist mostly of coarse coral sand, sometimes unconsolidated, sometimes, as at Loggerhead Key, forming a soft rock, quite different from the harder limestone of Key West. At Loggerhead its very recent origin is plainly seen by its containing occasionally pieces of metal from wrecks, such as bolts, nuts, nails, etc. East Key of the same group seems to be washing away at its southern end and forming anew at the north. North Key, which has been mentioned as having disappeared, is said to have had the only well of fresh water in the group. It was explained by my informant, probably correctly, as having been composed of very fine sand, more apt to retain the rain-water unmixed than the coarser sand of the other keys.

The marine fauna of the coral region of South Florida is a West Indian colony engrafted on the more or less North American fauna of the east and west coasts of the peninsula. From Cape Florida and from Cape Sable northward the reef corals and their commensals are not found, the calcareous is replaced by silicious sand, oyster banks fill the bays, and a great change is apparent by a mere look at the prevailing shells thrown up on the beaches.

The flora of the keys is very largely West Indian in its origin. Mr. Frederick Brendel has given in vol. viii. No. 8, of this journal, interesting remarks on the species of plants common to

[1] I would urge on the winter excursionists to that part of our country the exploration of the region of the Everglades, northwest of the Miami River, with regard to the number and distances of ancient reefs, which ought to assume the form of rocky islands in the marshes. Long Key in the Everglades, by its shape and parallelism to the known ancient reefs, must be of that character, and there are probably more. The fossil corals found in them would be of interest to compare with more recent ones. It would be desirable to know also how far north of Cape Florida coral rock extends along the coast. I take this opportunity to say that the Museum of Comparative Zoölogy in Cambridge would be thankful for a set of the fossil corals of Tampa Bay.

South Florida, the West Indies, and Mexico, to which I refer the reader. I would only state that the anomaly noticed by Mr. Brendel in the number of species common to South Florida and Mexico being so much smaller than those common to the former and the West Indies can hardly be explained by a former connection of the land as he seems to imply. The distribution of animals, as we shall see, would not bear out this theory.

No botanist, as far as I can find, has made a discrimination between the flora of the keys proper and that of the mainland of South Florida; it would no doubt show that some of the few plants common to Northern and Southern Florida do not extend to the islands; the pine is a conspicuous example, its growth being apparently incompatible with pure calcareous soil; the Pine Keys, back of the main range, are the only ones bearing a growth of pines, and they have silicious sand, as I was informed by Professor Agassiz. I have often regretted not having visited them. Seen from the middle of Key Biscayne Bay the difference between the mainland and the keys is quite conspicuous. The border of mangroves is of course the same on both sides, but above it on the former the horizon is closed by the pine forest so characteristic of the shores of the Southern States, while on the latter the larger trees are fig-trees of two or three species, the quassia (*Simaruba*), the torchwood (*Bursera*), the mahogany, and a few others, interspersed with a dense shrubbery, in which several species of *Eugenia* are perhaps the most common and characteristic. Near the water the *Coccoloba*, or sea-grape, forms conspicuous groups, and on muddy shores the mangrove and the *Avicennia*, called locally the black mangrove, are always ready to consolidate the new-made land, the former by its air roots and numerous floating fruits, the latter by its creeping roots. In sandy places the palmetto seems to monopolize the ground, but never rises to more than ten or fifteen feet.

The tree vegetation seems to be most luxuriant, comparatively speaking, about the central part of the chain of keys, say from Key Largo to Key West. At Key West it has an appearance of decline, though it is hardly a fair point of comparison, as most of the trees suitable for fire-wood have been destroyed and many trees and plants introduced which have changed the aspect of the vegetation. West of this, however, the change becomes more marked, until finally we reach the Tortugas, where I made it a point to try to collect every plant growing on the group. I think I nearly succeeded, and obtained only fourteen species, which my

friend, Mr. Lesquereux, had the kindness to determine for me. They are *Suriana maritima*, the largest shrub covering most of the islands, improperly called bay-cedar by the inhabitants; *Tournefortia gnaphalioides; Avicennia tomentosa*, a few crippled specimens on Bush Key, and also growing on the parade ground of Fort Jefferson; *Scævola Plumieri; Euphorbia glabella, Cordia bullata*, probably introduced near the light-house; *Ambrosia crithmifolia; Nasturtium tanacetifolium; Battatas littoralis;* a large *Opuntia*, probably introduced; an undetermined *Labiate; Cenchrus tribuloides; Cyperus microdontus* and *Eragrostis macrantha.*

This scarcity of plants may be attributed to various causes, but the principal one is no doubt the more recent formation of these islands, more imperfect consolidation, and the as yet insufficient accumulation of vegetable soil. The distribution of seeds may also be influenced by the currents in such a way as to be left in greater numbers on the keys farther east, which would be first touched by the eddy currents of the Gulf Stream; but this question I would only touch upon under great reserve.

It would be an interesting study for a resident botanist to collect the numerous seeds thrown on the beaches of Florida and test their germinative powers. Some kinds seem to germinate, but still not to grow up to maturity. Thus I have seen the cocoanut germinating among the rubbish thrown up by the sea, but do not recollect seeing a tree grown up under such circumstances, although it does well under cultivation. Among the most common and conspicuous seeds found on the beaches are the large beans of *Entada gigalobium*, so well protected by their hard skin that they stand transportation by the Gulf Stream as far as Spitzbergen. Yet they do not germinate in Florida, so far as I know.

The land animals, as has been stated, are mostly immigrants from the mainland, with some exceptions which will be noted. The few mammals are entirely North American, and it is interesting to note how far the different species have penetrated along the chain of islands. For much of this informatian I am indebted to Colonel Patterson, one of the oldest residents of Key West, and a keen sportsman in his younger days. The deer and the raccoon have wandered as far as Key West; beyond this no mammals are found. The deer is probably destroyed at present, but the raccoon is still not uncommon. There may be a small rodent in addition, and perhaps the aquatic rabbit of the Southern

States. The bear does not extend so far — I think only to Matacumbe — and is probably only a visitor at the time when the turtles lay their eggs, of which he is said to be very fond; there would be little food for him at other times. Key Largo which is connected by a narrow isthmus with the mainland has the mammals of the latter, opossums, squirrels, etc. A burrowing rabbit, according to Colonel Patterson, is found on Rabbit Key, a very small and isolated islet in the bay or sound between the mainland and the keys. To reach Key West from Key Largo, some fifteen or more channels (some of them three or four miles wide) have to be crossed in passing from island to island. The want of fresh water is the probable inducement for the undertaking.[1] The absence of North American mammals from Cuba and the Bahamas would seem to give a great antiquity to the present course of the Gulf Stream which has proved an impassable barrier.

Of birds little can be said on account of their wandering habits. After hurricanes, birds from Cuba are often taken here, which are not seen at other times. A list of the regular breeding birds would be interesting.

For the batrachia and reptiles I can only give a list for Key West, kindly made up for me by Mr. Garman from the collection in the Museum of Comparative Zoölogy. The batrachia are *Hyla cinerea* and *Scaphiopus solitarius;* the snakes, *Tropidonotus compressicaudus*, *Coryphodon constrictor* (Tortugas), *Elaphis obsoletus* and *guttatus*, *Liopeltis æstivus*, *Crotalus adamanteus;* the saurians, *Plestiodon quinquelineatum*, *Cnemidophorus sexlineatus*, *Anolis principalis*, and *Sphærodactylus notatus*. The chelonians are represented by *Thyrosternum Pennsylvanicum;* the salt-water terrapin is said to be found at the Marquesas, between Key West and the Tortugas, but I have never seen a specimen.

All of these, with the exception of *Sphærodactylus*, from Cuba, are North American species. The batrachia are said by Wallace to be very seldom represented in insular faunæ, being rapidly killed by salt water. The two species mentioned above may have been transported with soil from the mainland, which has been sometimes brought to enrich the gardens.

Of the insects I cannot speak. There will be probably found here a considerable mixture of North American, Cuban, and

[1] While on the subject of mammals I would mention that a very imperfectly known West Indian seal is found occasionally in numbers on the Dog rocks, northeast corner of Salt Key Bank, about one hundred miles from Key West.

Bahamian forms, as the distances are not too great to be traversed by most flying insects. It would be an interesting study for an entomologist to find out how far North American species have adapted themselves to the West Indian flora, and how far they have varied under this influence.

With regard to the land shells, I am enabled by the kindness of Mr. Thomas Bland, to give more extended lists than in the other departments. Mr. Bland, not content to give me the benefit of his own large stock of knowledge, has spared no pains to gather all the information within reach, principally from Mr. W. G. Binney and Mr. W. W. Calkins.

Mr. Binney remarks that the fauna of the keys is quite the same as that of the mainland from Tampa Bay to the Miami River, and that this fauna is about equally derived from the great "Southern Province" of the eastern region of North America and from the West Indies, and gives the following lists in corroboration: —

Species certainly derived from the "Southern Region" of North America, not from West Indies.	West Indian Species found in Florida.
Glandina truncata, everywhere.	Zonites Gundlachi, Key West.
Succinea campestris, Key West.	Patula vortex, mainland and keys.
Polygyra Carpenteriana, Key West, Key Biscayne.	Helix varians, Key West to Key Biscayne.
Polygyra septemvolva, Key West.	Cylindrella Poeyana, Miami River, Key West.
" cereolus, "	Macroceranus pontificus,[1] Miami River to Tampa.
" uvulifera, "	Macroceranus Gossei, Little Sarasota Bay.
Pupa variolosa, "	Bulimus marietinus, Miami River.
" modica, "	Strophia incana, mainland and keys.
" rupicola, "	Stenogyra octonoides, Miami River.
Helix pulchella, "	Stenogyra gracillima, Miami River, Key West.
Zonites minusculus, "	Lignus fasciatus, Miami River, Key West.
Helicina orbiculata, "	Orthalicus undatus, " "
	Chondropoma dentatum, Miami River, Key West.
	Cylindrella jejuna, Miami River, Key West.

From Mr. Calkins' list I add *P. incana* from Key West to Key Biscayne. That some species which are common to some of the West India Islands and to South Florida have had their origin in North America and spread from there, as stated by Mr. Binney, is a fact very difficult to account for. The currents are decidedly against it, and a former connection of the land not confirmed by a study of other classes.

We may recapitulate as follows from these notes, imperfect as

[1] Key West (Calkins).

they are: (1.) The vegetation of the Florida Keys is largely West Indian. (2.) The mammals are entirely North American, and no species common to Florida and West Indies, except perhaps some bats and the manatee,[1] which are not properly attached to the land. (3.) Reptiles and batrachia, North American with only one exception. The Cuban crocodile, lately discovered in South Florida, is never found on the keys. (4.) Land shells are about equally divided, with a slight preponderance of West Indian species.

On the whole, therefore, this small region is well entitled to be called a curious instance of intermingling of faunas, and worthy of being carefully studied in all its details, aside from the great interest it presents to the naturalist in its marine fauna and flora, and to the geologist as a working model of many of the agencies by which a large proportion of the sedimentary rocks have been formed.

A PROVISIONAL HYPOTHESIS OF PANGENESIS.[2]

BY W. K. BROOKS.

THE value of Darwin's Provisional Hypothesis of Pangenesis, as a legitimate attempt at a scientific interpretation of the facts of reproduction, is so evident that no apology for endeavoring to discuss the subject is necessary. I venture then to call attention to the following attempt to combine the hypotheses of Owen, Spencer, and Darwin in such a way as to escape the objections to which each is in itself liable, and at the same time to retain all that renders them valuable.

All characteristics which are fully established as peculiarities of the species are transmitted through the various forms of asexual reproduction, as well as by the ovum, which has in itself the power to develop, when excited by a proper stimulus which may or may not be the effect of impregnation, into a new individual of the parent form.

New characteristics, on the contrary, are transmitted through the agency of gemmules, which are thrown off by the cells implicated in the variation. These gemmules have not, like the ovum, power to develop into a new individual, but reproduce under

[1] The comparatively abundant fragments of manatee bones found by me in dredging off the Florida coast seem to indicate former migrations of that animal between Cuba and Florida. I believe it is not known now to leave the shores.

[2] Abstract of a paper read at the Buffalo meeting of the American Association for the Advancement of Science, August 23, 1876.

proper conditions the cell which formed them. They are stored up by the male gland and enter into its excretion, the seminal fluid, and are thus transmitted to the egg by impregnation. Since the body of the female is variable, like that of the male, some of the cells will occasionally form gemmules; some of these may be carried with the fluids of the body to the ovary, and thus gain access to an ovarian egg; but the female differs from the male in having no specialized organ for the aggregation and transmission of gemmules.

In this form the hypothesis demands only a very limited number of gemmules at any given time, since only those cells which are undergoing modification give rise to gemmules. We thus escape nearly all the difficulty of the Darwinian form of the hypothesis. We are also able to answer the objection raised by Galton, for the presence of great numbers of gemmules in the blood at any given time is not to be expected, and the testis and seminal receptacle are the only organs which normally contain any considerable number of them from the various parts of the body.

According to the new view we are to regard the male element as the originating and the female as the perpetuating factor in the reproductive process. The female is conservative, the male progressive. Adherence to type is brought about through the female, and adaptation to conditions through the male.

I will now give a more extended account of the manner in which gemmules are produced. An adult animal or plant is composed of cells which must be regarded as morphological individuals, for they exhibit all the properties which characterize an organism. They absorb nutriment, grow, give rise to formed material, and multiply asexually. These properties they can be proved to possess; we assume that they also have the power to give rise to eggs, or, to use Darwin's word, to gemmules capable of developing into similar cells. Assuming that this power, homologous with that of independent organisms, exists, let us see whether we can learn from the study of independent organisms the conditions under which it may be expected to manifest itself. We know that among animals and plants growth, development, and multiplication are so related that each can go on only at the expense of the others, and that anything which tends to check growth or development favors multiplication; we know too, that asexual and sexual multiplication are related in the same way. If the constituent cells of an organism are organisms in them-

selves, we should expect them to conform to the same laws. Most of the cells of the body are at any given time very perfectly adapted to the conditions under which they are placed, that is, such an adjustment has been brought about during the process of evolution of the organism, as to place each cell under such relations to its environment as are most favorable to the performance of its function in the body. This state of things will last until some unfavorable change takes place in the environment, either external or internal to the body. The adjustment between the cell thus affected and its conditions will of course be disturbed by the change, and if this change is great enough to check the performance of its normal functions, but not sufficiently great to destroy life, the cell will, after the analogy of other organisms, give birth to gemmules. As these gemmules when transmitted to the next generation are supposed to give rise to variations, we have a simple and consistent explanation of what is without doubt the greatest difficulty of the theory of natural selection: how, among the countless numbers of possible variations, a given cell ever happens to vary at the time change is needed. This explanation is all the more satisfactory since it simply embraces the unicellular organisms which compose the body under laws which are well established as applied to independent organisms. We can also understand why variations do not usually make their appearance in the individuals upon which the new conditions are first brought to bear, but in succeeding generations; for the new conditions do not result in direct variation, but in the production of gemmules which are transmitted to the next generation. It may perhaps be asked why a cell produced from a gemmule should be more variable than one produced by division. A cell formed by division commences its existence as a fully formed cell, but a gemmule has the absorption of food and the building of a body still before it, and it will therefore be more susceptible to external conditions, just as a house in process of construction is more easily altered than one which is finished.

If our assumption that newly acquired characteristics are transmitted by the male and those of long standing by the female is correct, the phenomena of crossing should furnish us with a test of the hypothesis. According to the theory of evolution, animals of allied species and varieties are the descendants of a common ancestor, and those characteristics which they have in common are due to this community of descent and are of long

standing, while those peculiarities which distinguish them from each other are in most cases of later origin. If, then, we make a reciprocal cross, that is, if we select two allied species or varieties and cross the male of one with the female of the other, and then reverse the process, using the female of the first and the male of the second, we should expect in most cases to find a difference in the offspring. Where the male of species A is crossed with the female of species B, we should expect the offspring to inherit from its mother the characteristics common to both parents, and from the father some of the distinctive marks of the species or variety A. In the second case we should expect it to unite some of the features of the form B to those peculiar to the genus. To take a special case; if we cross a stallion with a female ass we should expect, according to our hypothesis, to find that the offspring exhibited the characteristics of the Equidæ, together with some of the distinctive features of the horse, while we should expect to find that the offspring of the jackass and the mare united some of the specific features of the ass to those common to both parents. It is needless to say that this experiment has been tried thousands of times with a uniform result which agrees perfectly with the demands of our hypothesis. In some cases the result of reciprocal crosses seems to directly oppose our conclusions, but the difficulty is in many instances only apparent. A species sometimes differs from its allies, not in having acquired new characteristics, but by reversion or arrest, and such a species will transmit its distinctive features through the female rather than through the male. Thus the Niata cattle, which seem to be a reversion to an extinct form, are more prepotent over other varieties through the female than through the male.

TRACES OF A VOICE IN FISHES.

BY CHARLES C. ABBOTT, M. D.

IF speech be but the means of communicating emotions or intentions to other beings, even invertebrate animals possess faculties of the same nature. We see insects, such as ants, which live in so-called communities, carrying out elaborately preconcerted warlike undertakings and attacks. A beetle which in rolling the ball of dung inclosing its egg has allowed it to slip into a hole from which it is unable to extricate it, flies away, to return in a short time with a number of assistants suffi-

cient to push the ball up the sides of the declivity by coöperation of labor. These creatures must, therefore, unquestionably possess some means of communicating with each other concerning this combination. It requires no long observation of our song birds to distinguish the different tones by which they warn their young of danger, or call them to feed, or by which they attract each other to pair. These animals, therefore, have at their control a certain number of signals which are quite adequate to procure for them some few of the wants of their life, and these signals, as far as we can at present guess, have been acquired and inherited in the same manner as were their instincts." (Peschel.)

Although we are all familiar with the lazy drum-fish of our sea-coast, — and some may have heard those grunting sounds that have given this species its common name, — the little fishes of our inland brooks and more pretentious denizens of our rivers are looked upon as voiceless creatures; that if indeed they have ideas, they must express them entirely by movements, not of one portion, but by their whole bodies. But, in fact, the conditions that obtain among insects and birds, as detailed in our quotation from Dr. Peschel,[1] are, in a measure, applicable to our fishes; at least, in the several years of my studies of the habits of our more common species, I have concluded that certain sounds made by these fishes are really vocal efforts, and that their utterance is for the purpose of expressing an idea to others of their kind; and furthermore, that these sounds are closely connected with their breeding habits, although I have heard these same sounds at other seasons.

Probably no one has failed to notice the brilliant colors of the restless red-fin, as it darts to and fro through the clear waters of a crystal brook, or the crimson fins of the silvery roach, that ere summer has passed, pale to dull yellow and lose all their glow; but while with all our fishes there is at one time of the year a deepening of every tint, this is in no wise comparable to the gorgeous hues nature has vouchsafed to a certain few. My studies of the habits of these common fishes have suggested that the bright colors of spring, which are analogous to the breeding plumage of male birds, might possibly bear the same relationship to vocal sounds that the songs and plumage of birds bear to each other. With some exceptions, our finest songsters are dull-colored birds. Have our plainer-tinted fishes a compensation for this attraction of color in the ability to utter sounds?

[1] The Races of Man, page 101. By Oscar Peschel. D. Appleton & Co. 1876.

After several summers spent in observing the breeding habits of these common fishes, I have been able to form two tables, referring to the breeding habits and the relationship of color and supposed voice thereto, of sixteen species of fresh-water fishes. In the first of these, I have simply separated them into bright, and dull colored species; the bright coloration referring to the breeding dress or spring coloration. In the second list, I have separated them according to their supposed vocal powers, and absence of such powers; and it will be seen on comparison that a combination of voice and color does not occur.

TABLE I.[1]

Brilliant Colors.	*Dull or Silvery.*
Yellow perch.	Spineless perch.
Common sunfish.	Mud sunfish.
Banded sunfish.	Gizzard shad.
Red-fin.	Mullet.
	Eel.
	Cat-fish.
	Lamprey.

TABLE II.

Supposed Vocal Power.	*Voiceless.*
Spineless perch.	Yellow perch.
Mud sunfish.	Common sunfish.
Gizzard shad.	Red-tailed sunfish.
Mullet.	Banded sunfish.
Lamprey.	Chub.
Cat-fish.	Roach.
Eel.	Red-fin.
	Pike.
	Bill-fish.

We have here four species enumerated that are brilliantly colored, and seven that are dull or silvery; and of the former, none are believed to have any voice proper, while of the seven of the right-hand column, all are believed to be so endowed. In the right-hand column of Table II., it will be noticed that the "voiceless" species include the four highly colored fishes and five others, all of silvery tints, which I have carefully studied, that have no habit, so far as traceable, which would separate them from the list of species without voice. We can scarcely then avoid the conclusion, that with fishes as with birds the brilliantly colored males, as a rule, are mostly, if not wholly, dependent on their hues to attract the females in the amatory season.

Those who may be familiar with the common chub (*Semotilus*

[1] I have purposely omitted the sturgeon from the list of plainly colored fishes, as I desire to make a separate study of the habits of this fish.

corporalis) will doubtless urge as an exception, that the peculiar grunting sounds made by this fish when taken from the water entitle it to a place among the list of species supposed to have a voice; but I have not been able to detect this sound except at such a time, and as the fish is then out of water and struggling, it may be involuntary. On the other hand the deep bronze and golden-green tints of the fresh-water bass, or "mud sunfish" (*Acantharcus pomotis*), may be maintained to be a case of high coloration, and a sexual attraction; and the same might be said of the land-locked gizzard shad (*Dorosoma cepedianum*), but the former of these has been most frequently of all fishes observed by me to voluntarily utter sounds when confined in an aquarium; still I doubt not there are many exceptions, and one great objection, and at first it seems a fatal one, to the suggestions I have made is that there probably are so very many exceptions to the supposed rule. But to refer again to the case of birds. Assuming the correctness of evolution, as I do, then we need go back but a very short period in geological time to see the numerous species of our birds reduced to single representatives of each genus, and even far fewer of so-called genera. With the avifauna thus simplified, the differences that now exist between our sombre-hued songsters and gayly colored songless birds, were doubtless more marked; and might not this be held true of our fishes also? The vast influence brought to bear upon all animals by their surroundings and the increasing struggle for existence has evolved in later times and is evolving innumerable variations in the forms of life of the present time; and these changes have in so great a measure obscured the conditions that once characterized both our birds and fishes, in the matter of the relationship of voice and color, that what I believe to have been once a well-marked feature of animal life is now traced with difficulty. Nevertheless, the many instances of apparent voice that I have noticed, and their relationship as to color, induce me to believe that what is now scarcely a rule, perhaps, as obtaining among fishes, was once a law that governed them.

In studying these same fishes in another phase of their habits, we see that while all of the species enumerated are active throughout the day, it cannot be questioned that some of them are far more active at night, and shun, if undisturbed, the glare of midday sunshine. These partially, if not strictly nocturnal species are those that I have considered as having the power to give out or utter a truly vocal sound, and they are the more plainly

colored species. The brilliant tints being of little or no use by night necessitates the diurnal habits of those fishes possessing them, while the nocturnal species, with a voice as a compensation for color, are enabled to carry on a courtship in part by its aid which would be of little or no use during the day.

Having given an outline of the conclusions reached, as to the supposed relationship of voice and color among certain fishes, let us consider in detail the characteristic habits of two of the best-known and most widely differing species of the list given. As representing the voiceless but highly tinted fishes, let us take the common sunfish (*Pomotis vulgaris*), and on the other hand the equally familiar cat-fish (*Amiurus lynx*) as an instance of a fish that has the power of uttering a sound, — that has the rudiments of a voice.

With the bursting of the leaf-buds and disappearance of the ice from the shady nooks of our quiet inland ponds, the gayly tinted sunfish that all winter long has been lazily loafing in the deeper waters of his old-time haunts dons not another scaly coat, indeed, but so renews and polishes the old that he might well pass for another of his kind; and, coming boldly to the sunny shallows, darts restlessly about, admiring himself, I doubt not, but to his greater satisfaction being admired by others, and before the flowers of May have faded has gotten himself a mate. But the courtship of this gaudy fish has been no easy matter. Hundreds of his kind, as bright as he, have, like him, striven by the hour to clear the field of every rival; and the clear waters are often turbid with sand and grass torn from the bed of the stream, as the older males chase each other from point to point, endeavoring by a successful snap to rob each other of a fin. No courtship battles among birds are more earnestly fought; and as the bird with bedraggled feathers is wise enough to withdraw from the contest and quietly seek a mate when his soiled plumage is in part restored, so the sunfish with mangled fins retires from the nesting grounds. But not a sound has been made by these excited fishes, except that of the rippling water when cut by their spiny fins as they chanced to reach above the surface. Never, when for a moment quiet, have we chanced to see the delicate chain of silvery bubbles that escape from the mouth of the bass (mud sunfish) when, shall we say, calling to its mate? At night, I believe, the sunfish rests from his labors. I have not been able to detect any continuance of his spring-time vivacity after sunset, and am led to

conclude that his sole dependence in securing a mate is in his brilliant coloring.

What a contrast is presented in the lazy, dull-colored cat-fish that slowly wanders over the muddy bed of the stream, if perchance he is moving about at all, during the day! Not a motion can be detected that is not referable, without doubt, to so prosaic a matter as the search for food. If a dozen or more come together, it is but to hunt in concert, and nothing of the nature of a contest is to be seen. But after sunset, every one of their kind becomes suddenly more animated; there is a marked restlessness in their every movement, as they congregate in large numbers in some limited area. At such a time, their presence is to be detected not only by the aid of "submarine lanterns" and all the troublesome helps that one must employ to study fishes at night; there is an opportunity given to use one's ears as well as eyes, and by careful, patient waiting we may hear, even from the deeper waters, a gentle humming sound that, if noticed at all, by most people would be referred to the insect life teeming about them. If, knowing or suspecting the true origin of this gentle murmur, we can, without alarming the fish, float our boat carefully to a point directly above them, we will find that scores of chains of little air bubbles are rising to the surface; and as the sound increases or dies away, in proportion to the abundance or absence of the bubbles, it is safe to refer the sound to the fishes that by voluntarily expelling the air from their bodies produce the murmurs we have mentioned. But, thanks to the aquarium, by its aid we have confirmed it.

I have not the space, here, to enumerate all the circumstances connected with these voluntary emissions of sounds by certain of our fishes, seven species of which I have particularly mentioned. Brief references to the others must here suffice. Concerning the first mentioned of our little list, the spineless perch, or "pirate" (*Aphrodederus sayanus*): my knowledge of its habits have been mostly derived from aquarial studies, but although the diminutive size of the very largest specimens obtained — a little over four inches in length — rendered it very difficult to be certain that sound accompanied the expulsion of air from their bodies, I am almost sure I detected it, and the actions generally of the fish were such as to render it in a high degree probable that there was a sound heard by the female fishes of their kind.

Of the percoid, that I have here called the "mud sunfish"

(*Acantharcus pomotis*), there is no doubt. Not only in the muddy brooks where it is mostly found, but also when confined in an aquarium, this fish will utter at times a deep grunting sound that cannot be mistaken. That it is voluntary, too, is evident from the quick, nervous movement of the whole body, and wide distention of the gill-covers that accompanies the sound. These sounds and those of the cat-fish first called my attention to the subject of voluntary production of sound or "voice" in fishes. Like the spineless perch, this sunfish is, I think, strictly nocturnal in its habits, and, from aquarial observations I am led to believe, chooses a mate, and accompanies her to the nest for ovipositing only at night.

Of that interesting fish, the land-locked "gizzard shad" (*Dorosoma cepedianum*), my observations have led to the detection of a very audible, whirring sound, not unlike the deeper notes of a coarse string of an æolian harp. Those who may have noticed, at times, the vibrating thrill that arises from the wind passing over a number of telegraph wires, will have heard a sound nearly identical. I judge that both sexes utter this sound in concert; but it may be that during the early spring the sexes separate, to come together again some few weeks later, when spawning commences, and, in such a case, that only the males were "singing." We find, especially in the herring tribe, that the sexes migrate separately; but in the case of the gizzard shad, when land-locked, as there could be no migration, this separation probably does not occur.

The chub-sucker or mullet (*Moxostoma oblongum*) is another example of those dull-colored, nocturnal fishes that frequent streams with muddy beds thickly overgrown with water plants, and which have the power of audibly forcing air from their bodies. In April, with a noticeable deepening of their coloration, there is increased activity in every movement, and, wholly unlike their actions by day, at night they swim quite near the surface, and utter a single prolonged note accompanied by a discharge of air-bubbles. They appear to project their jaws just above the water, and force the air from beneath their gill-covers immediately below the surface, as there are two parallel streams of bubbles. When seen in the moonlight, these bubbles appear like minute silver beads. Swimming in this way, the mullet will often proceed a hundred yards, uttering their peculiar "call" four or five times while passing over that distance.

In the lamprey (*Petromyzon nigricans*) we have a semi-noc-

turnal species that I have had but few opportunities of observing closely, as it frequents rapidly running water and spends much the greater portion of its time under flat stones. On two occasions I have had opportunities of watching them, when paired, and thought that they uttered a peculiar sound, quite dissimilar to that of any other fish note I had heard, but it was unaccompanied so far as I could determine by a chain of air bubbles rising to the surface, such as always are seen to accompany the notes uttered by the chub-sucker or cat-fish. This same noise, or one very similar, was made by them when captured and taken from the water, and, in both instances, may have been involuntary. From their peculiar anatomy, they are an exceedingly interesting species with reference to the subject of voice so-called; and I regret that my experience when keeping them in an aquarium did not confirm my suspicions when studying them in their proper habitat. When in an aquarium, I occasionally heard a prolonged buzzing sound that had many of the characteristics of what I have considered voice in other species, but it was too monotonous and protracted to be considered a voluntarily produced sound or vocal effort. If the more voice-like sounds heard, as mentioned, are characteristic of their breeding season, then it probably is strictly a "love call," and certainly, when paired, these fishes are exceedingly amorous.

In all the instances so far mentioned of voluntarily expressed sounds or utterances of fishes, they have been referred to in connection with their ordinary breeding habits; not that they are never heard at other times, but because these "calls" or "songs," or whatever they should be considered, are a marked feature of that season. In our common eel (*Anguilla acutirostris*) we have an instance of a fish possessing unmistakable evidences of voice, yet which may be said to have no breeding season, at least when found far inland. Without inquiring into the still doubtfully determined breeding habits of the eel, it is sufficient here to say, that in countless thousands they pass from the sea up our rivers, and so, far inland through the most insignificant brooks, and certainly often reach isolated ponds. From these ponds they seldom escape. Here they grow to a large size, and live to a great age; yet summer after summer passes without any indication of their breeding. No species of fresh-water fish is more strictly nocturnal in its habits, and none are so easily studied, inasmuch as at night they are not only very active but keep continually near the surface. In the matter of voice, eels

utter a more distinctly musical sound than any other of those I have mentioned. It is a single note, frequently repeated, and has a slightly metallic resonance. I have heard this sound only at night, and never when the animal is taken from the water by day, as when captured by a hook, so that I presume it is not involuntary. When a large number of eels are congregated in a small space, as when feeding on some decayed animal, I have heard this note very frequently repeated, and from the volume of sound I judge that large eels utter only a note that is distinctly audible. It is well known that this fish occasionally leaves the water voluntarily and wanders a considerable distance to other streams or ponds; and when through protracted droughts a pond becomes quite dry, while other fishes perish, the eels suffer little inconvenience, as, snake-like, they crawl at night over a considerable stretch of land, guided by some undetermined instinct to the nearest water. At such a time the eel will occasionally utter this same clear note, especially if surprised. From what I have been able to determine concerning these overland journeys of the eel, they are undertaken only when the grass is well moistened with dew, and a surface of any extent devoid of thick vegetation is an effectual barrier to their progress. I would add, that I have noticed when "bobbing" for eels, namely, catching them without injury to their mouths, that when squirming about the bottom of the boat they not unfrequently utter this same sound, not inaptly compared, perhaps, to the faint squeak of a mouse.

I have given one instance, that of the common Pomotis, of a fish that is strictly a diurnal species, of bright coloration, and that passes through the various phases of courtship and nidification without uttering a sound; and on the other hand, more or less in detail, referred to several other fishes that are all of dull coloration, are nocturnal in their habits, and, whether voluntarily or not, certainly at times do utter sounds. They cannot be considered as simply making a noise, this arising from the unavoidable result of certain muscular movements. The action that produces the sound, on the contrary, I have been led to believe is one intentionally performed that the sound may result, and the fish has a distinct purpose in view in the latter, it being a call to others of its kind, which is responded to by the approach of those hearing it and for whom it was intended.

When we carefully study the entire ichthyic fauna of a given locality, say of a single small stream, as I have done in this case,

we shall undoubtedly find some exceptions to this supposed rule of dissociation of coloration and voice; but these may be less in number than appear to us, when we consider how great a number of diminutive species are found in every stream, that cannot be determined in which class they should be placed; for while many are dull colored and doubtless possess voice (the well-known mud minnow, *Melanura limi*, is an excellent example), this is too faint a sound for us to detect; but from the fact that this peculiarity can be determined in some of the larger species, it is not improbable that in earlier geological eras fishes generally were of sombre tints, and possessed more decided vocal powers than at present; and that in the subsequent differentiation of genera and species, color was more and more evolved as a generic character, and voice became proportionately less a feature of our fishes, but was retained in some and reappears in still stronger development in those connecting links between fishes and the higher vertebrates, culminating in the batrachians, where it is perfected by the presence of a larynx.

In conclusion, it is well to quote briefly from an author who has most scientifically discussed this same subject.[1]

He writes: "Not only is there every reason to believe that the majority of sounds produced by fishes are not casual utterances, but are truly voluntary, but there is among such as give vent to them a most remarkable development of the organs of hearing in all essential particulars, for example, in the semi-circular canals, otoliths, and nerves, correlative with the degree of perfection of the instrument. Further than this, as the sounds generally excel in frequency and intensity at the breeding season, it will not be unreasonable to regard them, — granting, as we do, that the chirp of the cricket and the croak of the frog is each in its way an alluring serenade, — as nuptial hymns, or, to use language ascribed to Plutarch, as 'deafening epithalamia.' More than this; seeing that the carp, and others of the same family, have given unmistakable proofs of their aptitude to receive some rudiments of education, and in particular to perceive certain sounds, it can yet be possible that the moral admonitions of a St. Anthony of Padua — by many still regarded as a work of supererogation — may, no less than the amorous twang of the vesical zither, after all not have fallen upon totally deaf ears."

[1] Songs of Fishes. By John C. Galton. Popular Science Review, October, 1874. (Consult also Recherches sur les Bruits et Sons expressifs que sont entendre les Poissons d'Europe, par M. Dufossé. (Annales des Sciences Naturelles. Tom. xix., xx., 1874.) With many illustrations. This article doubtless inspired the excellent one by Mr. Galton. — EDITOR AMERICAN NATURALIST.)

THE GEOGRAPHICAL DISTRIBUTION OF ANIMALS: GENERAL CONCLUSIONS.[1]

BY ALFRED R. WALLACE.

HAVING now closed our survey of the animal life of the whole earth, — a survey which has necessarily been encumbered with a multiplicity of detail, — we proceed to summarize the general conclusions at which we have arrived, with regard to the past history and mutual relations of the great regions into which we have divided the land surface of the globe.

All the palæontological no less than the geological and physical evidence, at present available, points to the great land masses of the northern hemisphere as being of immense antiquity and as the area in which the higher forms of life were developed. In going back through the long series of the Tertiary formations in Europe, Asia, and North America, we find a continuous succession of vertebrate forms, including all the highest types now existing or that have existed on the earth. These extinct animals comprise ancestors or forerunners of all the chief forms now living in the northern hemisphere ; and as we go back farther and farther into the past, we meet with ancestral forms of those types also, which are now either confined to or specially characteristic of the land masses of the southern hemisphere. Not only do we find that elephants and rhinoceroses and hippopotami were once far more abundant in Europe than they are now in the tropics, but we also find that the apes of West Africa and Malaya, the lemurs of Madagascar, the Edentata of Africa and South America, and the marsupials of America and Australia were all represented in Europe (and probably also in North America) during the earlier part of the Tertiary epoch. These facts, taken in their entirety, lead us to conclude that during the whole of the Tertiary and perhaps during much of the Secondary periods, the great land masses of the earth were, as now, situated in the northern hemisphere ; and that here alone were developed the successive types of vertebrata, from the lowest to the highest. In the southern hemisphere there appear to have been three considerable and very ancient land masses, varying in extent from time to time, but always keeping distinct from each other, and represented, more or less completely, by Australia, South Africa, and South America of our time. Into these

[1] Chapter xvi. of The Geographical Distribution of Animals. New York : Harper and Brothers.

flowed successive waves of life, as they each in turn became temporarily united with some part of the northern land. Australia appears to have had but one such union, perhaps during the middle or latter part of the Secondary epoch, when it received the ancestors of its Monotremata and marsupials, which it has since developed into a great variety of forms. The South African and South American lands, on the other hand, appear each to have had several successive unions and separations, allowing first of the influx of low forms only (Edentata, Insectivora, and lemurs), subsequently of rodents and small Carnivora, and latest of all of the higher types of Primates, Carnivora, and Ungulata.

During the whole of the Tertiary period, at least, the northern hemisphere appears to have been divided, as now, into an eastern and a western continent, always approximating and sometimes united towards the north, and then admitting of much interchange of their respective faunas, but on the whole keeping distinct, and each developing its own special family and generic types, of equally high grade, and generally belonging to the same orders. During the Eocene and Miocene periods, the distinction of the Palæarctic and Nearctic regions was better marked than it is now, as is shown by the floras no less than by the faunas of those epochs. Dr. Newberry, in his Report on the Cretaceous and Tertiary Floras of the Yellowstone and Missouri Rivers, states, that although the Miocene flora of Central North America corresponds generally with that of the European Miocene, yet many of the tropical, and especially the Australian types, such as *Nakea* and *Dryandra*, are absent. Owing to the recent discovery of a rich Cretaceous flora in North America, probably of the same age as that of Aix-la-Chapelle in Europe, we are able to continue the comparison, and it appears that at this early period the difference was still more marked. The predominant feature of the European Cretaceous flora seems to have been the abundance of Proteaceæ, of which seven genera now living in Australia or the Cape of Good Hope have been recognized, besides others which are extinct. There are also several species of *Pandanus*, or screw-pine, now confined to the tropics of the eastern hemisphere, and along with these oaks, pines, and other more temperate forms. The North American Cretaceous flora, although far richer than that of Europe, contains no Proteaceæ or *Pandani*, but immense numbers of forest trees of living and extinct genera. Among the former we have oaks, beeches,

willows, planes, alders, dogwood, and cypress, together with such American forms as magnolias, sassafras, and liriodendrons. There are also a few not now found in America, as *Araucaria* and *Cinnamomum*, the latter still living in Japan. This remarkable flora has been found over a wide extent of country, New Jersey, Alabama, Kansas, and near the sources of the Missouri in the latitude of Quebec, so that we can hardly impute its peculiarly temperate character to the great elevation of so large an area. The intervening Eocene flora approximates closely in North America to that of the Miocene period, while in Europe it seems to have been fully as tropical in character as that of the preceding Cretaceous period, fruits of *Nipa*, *Pandanus*, *Anona*, *Acacia*, and many Proteaceæ occurring in the London clay at the mouth of the Thames.

These facts appear, at first sight, to be inconsistent, unless we suppose the climates of Europe and North America to have been widely different in those early times; but they may perhaps be harmonized on the supposition of a more uniform and a somewhat milder climate then prevailing over the whole northern hemisphere, the contrast in the vegetation of these countries being due to a radical difference of type, and therefore not indicative of climate. The early European flora seems to have been a portion of that which now exists only in the tropical and subtropical lands of the eastern hemisphere, and as much of this flora still survives in Australia, Tasmania, Japan, and the Cape of Good Hope, it does not necessarily imply more than a warm and equable temperate climate. The early North American flora, on the other hand, seems to have been essentially the same in type as that which now exists there, and which in the Miocene period was well represented in Europe; and it is such as now flourishes best in the warmer parts of the United States. But whatever conclusion we may arrive at on the question of climate, there can be no doubt as to the distinctness of the floras of the ancient Nearctic and Palæarctic regions; and the view derived from the study of their existing and extinct faunas — that these two regions have, in past times, been more clearly separated than they are now — receives strong support from the unexpected evidence now obtained as to the character and mutations of their vegetable forms, during so vast an epoch as is comprised in the whole duration of the Tertiary period.

The general phenomena of the distribution of living animals, combined with the evidence of extinct forms, lead us to conclude

that the Palæarctic region of early Tertiary times was, for the most part, situated beyond the tropics, although it probably had a greater southward extension than at the present time. It certainly included much of North Africa, and perhaps reached far into what is now the Sahara, while a southward extension of its central mass may have included the Abyssinian highlands, where some truly Palæarctic forms are still found. This is rendered probable by the fossils of Perim Island a little farther east, which show that the characteristic Miocene fauna of South Europe and North India prevailed so far within the tropics. There existed, however, at the extreme eastern and western limits of the region, two extensive equatorial land areas, our Indo-Malayan and West African sub-regions, both of which must have been united for more or less considerable periods with the northern continent. They would then have received from it such of the higher vertebrates as were best adapted for the peculiar climatal and organic conditions which everywhere prevail near the equator; and these would be preserved, under variously modified forms, when they had ceased to exist in the less favorable and constantly deteriorating climate of the north. At later epochs, both these equatorial lands became united to some part of the great South African continent (then including Madagascar), and we thus have explained many of the similarities presented by the faunas of these distant and generally very different countries.

During the Miocene period, when a subtropical climate prevailed over much of Europe and Central Asia, there would be no such marked contrast as now prevails between temperate and tropical zones; and at this time much of our Oriental region, perhaps, formed a hardly separable portion of the great Palæarctic land. But when, from unknown causes, the climate of Europe became less genial, and when the elevation of the Himalayan chain and the Mongolian plateau caused an abrupt difference of climate on the northern and southern sides of that great mountain barrier, a tropical and a temperate region were necessarily formed; and many of the animals which once roamed over the greater part of the older and more extensive region now became restricted to its southern or northern divisions, respectively. Then came the great change we have already described (vol. i. p. 288), opening the newly formed plains of Central Africa to the incursions of the higher forms of Europe, and following on this, a still further deterioration of climate, resulting in that marked contrast between temperate and tropical faunas, which is

now one of the most prominent features in the distribution of animal as well as of vegetable forms.

It is not necessary to go into any further details here, as we have already, in our discussion of the origin of the fauna of the several regions, pointed out what changes most probably occurred in each case. These details are, however, to a great extent speculative, and they must remain so till we obtain as much knowledge of the extinct faunas and past geological history of the southern lands as we have those of Europe and North America. But the broad conclusions at which we have now arrived seem to rest on a sufficiently extensive basis of facts, and they lead us to a clearer conception of the mutual relations and comparative importance of the several regions than could be obtained at an earlier stage of our inquiries.

If our views of the origin of the several regions are correct, it is clear that no mere binary division into north and south, or into east and west can be altogether satisfactory, since at the dawn of the Tertiary period we still find our six regions, or what may be termed the rudiments of them, already established. The north and south division truly represents the fact that the great northern continents are the seat and birthplace of all the higher forms of life, while the southern continents have derived the greater part, if not the whole of their vertebrate fauna from the north; but it implies the erroneous conclusion that the chief southern lands, Australia and South America, are more closely related to each other than to the northern continent. The fact, however, is that the fauna of each has been derived, independently, and perhaps at very different times, from the north, with which they therefore have a true genetic relation, while any intercommunion between themselves has been comparatively recent and superficial, and has in no way modified the great features of animal life in each. The east and west division represents — according to our views — a more fundamental diversity, since we find the northern continent itself so divided in the earliest Eocene and even in Cretaceous times, while we have the strongest proof that South America was peopled from the Nearctic, and Australia and Africa from the Palæarctic region; hence, the eastern and western hemispheres are the two great branches of the tree of life of our globe. But this division, taken by itself, would obscure the facts, firstly, of the close relation and parallelism of the Nearctic and Palæarctic regions, not only now, but as far back as we can clearly trace them in the past; and

secondly, of the existing radical diversity of the Australian region from the rest of the eastern hemisphere.

Owing to the much greater extent of the old Palæarctic region (including our Oriental) and the greater diversity of Mammalia it appears to have produced, we can have little doubt that here was the earliest seat of the development of the vertebrate type, and probably of the higher forms of insects and land-mollusks. Whether the Nearctic region ever formed one mass with it, or only received successive immigrations from it by northern land connections both in an easterly and westerly direction, we cannot decide; but the latter seems the most probable supposition. In any case, we must concede the first rank to the Palæarctic and Oriental regions, as representing the most important part of what seems always to have been the great continent of the earth, and the source from which all the other regions were supplied with the higher forms of life. These once formed a single great region which has been since divided into a temperate and a tropical portion, now sufficiently distinct, while the Nearctic region has, by deterioration of climate, suffered a considerable diminution of productive area, and has in consequence lost a number of its more remarkable forms. The two temperate regions have thus come to resemble each other, more than they once did, while the Oriental retains more of the zoölogical aspect of the great northern regions of Miocene times. The Ethiopian form having been once an insular region, where lower types of vertebrates alone prevailed, has been so overrun with higher types from the old Palæarctic and Oriental lands that it now rivals, or even surpasses, the Oriental region in its representation of the ancient fauna of the great northern continent. Both of our tropical regions of the eastern hemisphere possess faunas which are to some extent composite, being made up in different proportions of the productions of the northern and southern continents, — the former prevailing largely in the Oriental, while the latter constitutes an important feature in the Ethiopian fauna. The Neotropical region has probably undergone great fluctuations in early times; but it was, undoubtedly, for long periods completely isolated, and there developed the Edentate type of mammals and the Formicaroid type of passerine birds into a variety of forms, comparable with the diversified marsupials of Australia, and typical Passeres of the eastern hemisphere. It has, however, received successive infusions of higher types from the north, which now mingle in various degrees with

its lower forms. At an early period it must have received a low form of Primates, which has been developed into the two peculiar families of American monkeys; while its llamas, tapirs, deer, and peccaries came in at a later date, and its opossums and extinct horses probably among the latest. The Australian region alone, after having been united with the great northern continent at a very early date (probably during the Secondary period), has ever since remained more or less completely isolated, and thus exhibits the development of a primeval type of mammal, almost wholly uninfluenced by any incursions of a later and higher type. In this respect it is unique among all the great regions of the earth.

We see, then, that each of our six regions has had a history of its own, the main outlines of which we have been able to trace with tolerable certainty. Each of them is now characterized — as it seems to have been in all past time of which we have any tolerably full record — by well-marked zoölogical features, while all are connected and related in the complex modes we have endeavored to unravel. To combine any two or more of these regions, on account of existing similarities which are for the most part of recent origin, would obscure some of the most important and interesting features of their past history and present condition. And it seems no less impracticable to combine the whole into groups of higher rank, since it has been shown that there are two opposing modes of doing this, and that each of them represents but one aspect of a problem which can only be solved by giving equal attention to all its aspects.

For reasons which have been already stated and which are sufficiently obvious, we have relied almost exclusively on the distribution of living and extinct Mammalia in arriving at these conclusions. But we believe they will apply equally to elucidate the phenomena presented by the distribution of all terrestrial organisms, when combined with a careful consideration of the various means of dispersal of the different groups and the comparative longevity of their species and genera. Even insects, which are perhaps of all animals the farthest removed from Mammalia in this respect, agree in the great outlines of their distribution, with the vertebrate orders. The regions are admittedly the same, or nearly the same for both, and the discrepancies that occur are of a nature which can be explained by two undoubted facts, the greater antiquity, and the greater facilities for dispersal of insects.

But this principle, if sound, must be carried farther and be applied to plants also. There are not wanting indications that this may be successfully done; and it seems not improbable that the reason why botanists have hitherto failed to determine, with any unanimity, which are the most natural phytological regions, and to work out any connected theory of the migrations of plants is, because they have not been furnished with the clue to the past changes of the great land masses, which could only be arrived at by such an examination of the past and present distribution of the higher animals as has been here attempted. The difficulties in the way of the study of the distribution of plants, from this point of view, will be undoubtedly very great, owing to the unusual facilities for distribution many of them possess and the absence of any group which might take the place of the Mammalia among animals and serve as a guide and standard for the rest. We cannot expect the regions to be so well defined in the case of plants as in that of animals, and there are sure to be many anomalies and discrepancies, which will require long study to unravel. The six great regions here adopted are, however, as a whole, very well characterized by their vegetable forms. The floras of tropical America, of Australia, of South Africa, and of Indo-Malaya stand out with as much individuality as do the faunas, while the plants of the Palæarctic and Nearctic regions exhibit resemblances and diversities of a character not unlike those found among the animals.

This is not a mere question of applying to the vegetable kingdom a series of arbitrary divisions of the earth, which have been found useful to zoölogists, for it really involves a fundamental problem in the theory of evolution. The question we have to answer is, firstly, whether the distribution of plants is like that of animals, mainly and primarily dependent on the past revolutions of the earth's surface, or whether other and altogether distinct causes have had a preponderating influence in determining the range and limits of vegetable forms; and secondly, whether those revolutions have been in their general outlines correctly interpreted by means of a study of the distribution and affinities of the higher animals. The first question is one for botanists alone to answer, but on the second point, the author ventures to hope for an affirmative reply, from such of his readers as will weigh carefully the facts and arguments he has adduced.

The hypothetical view as to the more recent of the great

geographical changes of the earth's surface here set forth, is not the result of any preconceived theory, but has grown out of a careful study of the facts accumulated, and has led to a considerable modification of the author's previous views. It may be described as an application of the general theory of evolution, to solve the problem of the distribution of animals; but it also furnishes some independent support to that theory, both by showing what a great variety of curious facts are explained by its means, and by answering some of the objections which have been founded on supposed difficulties in the distribution of animals in space and time.

It also illustrates and supports the geological doctrine of the general permanence of our great continents and oceans, by showing how many facts in the distribution of animals can only be explained and understood on such a supposition, and it exhibits in a striking manner the enormous influence of the Glacial epoch, in determining the existing zoölogical features of the various continents. And lastly, it furnishes a more consistent and intelligible idea than has yet been reached by any other mode of investigation of all the more important changes of the earth's surface that have probably occurred during the entire Tertiary period, and of the influence of these changes in bringing about the general features, as well as many of the more interesting details and puzzling anomalies of the geographical distribution of animals.

RECENT LITERATURE.

MEMOIRS OF THE GEOLOGICAL SURVEY OF KENTUCKY.[1] — The first fruits of the reëstablished Geological Survey of Kentucky appear in a large and admirably illustrated volume of memoirs. Professor Shaler publishes papers on the antiquity of the caverns and on the fossil brachiopods of the Ohio Valley, and, in conjunction with Mr. Carr contributes the first of a series of papers on the prehistoric remains of Kentucky; while Mr. Allen furnishes an elaborate memoir on the American bisons, living and extinct. The first of Professor Shaler's papers has already appeared in the memoirs of the Boston Natural History Society, and Mr. Allen's monograph is published simultaneously by the Museum of Comparative Zoölogy. The latter paper forms the bulk of the volume (246 pp.) and is illustrated by twelve plates, half of them double, and by a map of North America. It is one of the most com-

[1] *Memoirs of the Geological Survey of Kentucky.* N. S. SHALER, Director. Vol. I. Cambridge, 1876. 4to, pp. 360, 27 plates, 1 map.

plete monographs ever published in this country, and a notable contribution to American science. The author recognizes two species of fossil bisons in America, *B. latifrons* and *B. antiquus* and a single living species, *B. Americanus*, of which he considers *B. antiquus* the immediate progenitor. The systematic part of the work, including a full account of the variation and habits of the recent species, extends over seventy pages, and the plates are illustrative of this portion. The map accompanies the larger part of the work, which relates to the past and present geographical distribution of the American bison and presents an appalling picture of the reckless waste and rapidly diminishing numbers of this noble animal. By most painstaking research among historical works and systematic inquiry among living witnesses, he has established the boundaries of the range of the "buffalo" as it existed when the white man first landed in America and at successive epochs to the present time, when it has become separated into a northern and a southern herd occupying comparatively restricted areas. The details extend over one hundred pages, but in the first part of his work Mr. Allen gives a general summary, as follows: —

"The habitat of the bison formerly extended from Great Slave Lake on the north, in latitude about 62°, to the northwestern provinces of Mexico, as far south as latitude 25°. Its range in British North America extended from the Rocky Mountains on the west to the wooded highlands about six hundred miles west of Hudson's Bay, or about to a line running southeastward from the Great Slave Lake to the Lake of the Woods. Its range in the United States formerly embraced a considerable area west of the Rocky Mountains, its recent remains having been found in Oregon as far west as the Blue Mountains, and further south it occupied the Great Salt Lake Basin, extending westward even to the Sierra Nevada Mountains, while less than fifty years since it existed over the head waters of the Green and Grand rivers, and other sources of the Colorado. East of the Rocky Mountains its range extended southward far beyond the Rio Grande, and eastward throughout the region drained by the Ohio River and its tributaries. Its northern limit east of the Mississippi was the Great Lakes, along which it extended eastward to near the eastern end of Lake Erie. It appears not to have occurred south of the Tennessee River, and only to a limited extent east of the Alleghanies, chiefly in the upper districts of North and South Carolina."

"Its present range embraces two distinct and comparatively small areas. The southern is chiefly limited to Western Kansas, a part of the Indian Territory, and Northwestern Texas, — in all together embracing a region about equal in size to the present State of Kansas. The northern district extends from the sources of the principal southern tributaries of the Yellowstone northward into the British Possessions, embracing an area not much greater than the present Territory of Montana.

Over these regions, however, it is rapidly disappearing,[1] and at its present rate of decrease will certainly become wholly extinct during the next quarter of a century." (Pages 54–55.)

There can be no question that the present generation will see the utter extinction of the bison unless some means are speedily taken by the general government, or by the territories to which its range is now restricted, to protect it by the establishment and stringent enforcement of laws providing for close time and limited slaughter. One hundred thousand killed in four months around Fort Dodge; two hundred thousand in a single season in Kansas, merely for the hides; three thousand by one man in one winter, — such are the statistics to which our attention is called.

Mr. Allen also gives a chapter on the products of the bison, the chase, and the possibilities of domestication; and Professor Shaler adds an interesting note on its age in the Ohio Valley, where he judges that the animal made its advent very recently, principally because its bones occur at Big Bone Lick only in the more superficial strata, where they are exceedingly abundant.

Professor Shaler's paper on the brachiopods is the first of a series, and treats of but a few species; these, however, are described with the greatest minuteness and care and very richly illustrated by heliotypes. In their joint essay on prehistoric remains, Messrs. Shaler and Carr discuss implements only, leaving other subjects for future treatment. All of the objects they describe and figure are "surface finds," and they profess to make no attempt to assign any of the specimens that have come within their observation to any particular period of time or phase of civilization. The introductory remarks on the mode of manufacturing stone implements by savage races and the chapters on the source of distribution of the stone implements of Kentucky, and on their antiquity, will be found very interesting.

HAECKEL'S HISTORY OF CREATION.[2] — Had Mr. Darwin when he first conceived the idea of natural selection, on his return from the voyage of the Beagle, had this book of Haeckel's thrust into his hands, he might then have stood aghast at the lengths to which the audacious German author goes. Here is a genealogical table of the entire organic world — the work of how many coming centuries we dare not predict — anticipated and set down in actual tables with all the assurance and confidence of an old-time prophet. The missing links even are all christened and diagnosed, from those which he thinks connected man with the

[1] If Colonel Dodge's statements in his recently published work, The Hunting-Grounds of the Great West, may be trusted, the range of the bison was already much restricted in 1876.

[2] *The History of Creation: or, the Development of the Earth and its Inhabitants by the Action of Natural Causes.* From the German of ERNST HAECKEL. The Translation revised by Prof. E. RAY LANKESTER. In 2 vols. New York: D. Appleton & Co. 1876. 12mo. $5.00.

monkeys to those which bound him to the Ascidians, and so on to the "primordial slime." As to reducing man's free will to that of a monad, his soul to the functional activity of the brain, his creator to the energy pervading matter, — in this Haeckel was caught napping; it is an old story. We are from first to last struck by the guileless faith of the man, a quality sometimes combined with an intensity of purpose and, we may add, an intolerance of opposing views which characterize the seer. We have here none of the halting in judgment and caution of Darwin, but rather the special pleading of the advocate of a unique theory which gives no quarter to any other.

The merit of the History of Creation is that it gives a rapid, clear-cut, dogmatic sketch of the subject. And though Haeckel's mode of settling the universe may be quite different from ours, his sketch of the origin of the animal world may be a rough approximation to what will probably be found on future research a reasonably truthful history. As an exposition of Darwinism as such, with its possible, not probable, consequences, it is the best in the language, now that we have such an excellent translation of the Geschöpfungsgeschichte which was published in 1868. The work is certainly original and striking in its many suggestions, and it has this unusual merit, that as an exposition of Darwinism by an ultra Darwinian it gives Lamarck full credit as the founder of the modern doctrine of transmutation or evolution. The work has so long been in the hands of the public that it would be superfluous for us to enter into a more detailed criticism or examination of its contents, but in closing we would say that any naturalist who has not read it has a treat before him, whether he accepts all the author's conclusions or not.

THE WARFARE OF SCIENCE.[1] — Though the battle of evolution has been fought, and the victory of the evolutionists complete, divines and metaphysicians falling into the lines of the victors, there are some who do not seem to be aware that they have been vanquished. Their eyes may be opened by President White's candid and impartial review of the struggles of scientific men with the bigoted of past ages as well as of the present period. He concludes: "First. In every case, whether the war has been long or short, forcible or feeble, science has at last gained the victory. Secondly. In every case interference with science, in the supposed interest of religion, has brought dire evils on both. Thirdly. In every case while this interference, during its continuance, has tended to divorce religion from the most vigorous thinking in the world and to make it odious to multitudes of the most earnest thinkers, the triumph of science has led its former conscientious enemies to make new interpretations and lasting adjustments, which have proved a blessing to religion, ennobling its conceptions and bettering its methods."

JOHNSON'S CYCLOPÆDIA.[2] — We have already called attention to

[1] *The Warfare of Science.* By ANDREW D. WHITE, LL. D. New York: D. Appleton & Co. 12mo, pp. 151. $1.00.

[2] *Johnson's New Universal Cyclopædia: a Scientific and Popular Treasury of Useful*

this work and to the features that render it especially serviceable to naturalists. It is strong in the scientific articles. The present volume contains articles by Abbe, Barnard, T. M. Brewer, Cope, Farlow, Gray, Goodale, Gill, Guyot, Henry, Marsh, Mayer, Morgan, Newberry, Packard, Pumpelly, Riley, Shaler, Verrill, and Wurtz. We regret to see no biographical notice of the late Mr. F. B. Meek, so eminent as a palæontologist, nor of Haeckel or Gegenbaur. The fourth volume will appear early this year.

Recent Books and Pamphlets. — The Geographical Distribution of Animals. With a Study of the Relations of Living and Extinct Faunas, as elucidating the Past Changes of the Earth's Surface. By Alfred Russel Wallace. In two volumes. With Maps and Illustrations. New York: Harper & Brothers. 1876. 8vo, pp. 503, 607. $10.00.

Climate and Time in their Geological Relations: a Theory of Secular Changes of the Earth's Climate. By James Croll. New York; D. Appleton & Co. 1875. 12mo, pp. 577.

The History of Creation: or the Development of the Earth and its Inhabitants by the Action of Natural Causes. A popular exposition of the Doctrine of Evolution in general, and of that of Darwin, Goethe, and Lamarck in particular. From the German of Ernst Haeckel. The Translation revised by Prof. E. Ray Lankester. In 2 vols. New York: D. Appleton & Co. 1876. 12mo, pp. 374, 408. With Illustrations. $5.00.

A Class-Book of Chemistry, on the Basis of the New System. By Edward L. Youmans, M. D. Rewritten and revised, with many new Illustrations. New York: D. Appleton & Co. 1876. 12mo, pp. 348. $1.75.

Elements of Physics or Natural Philosophy. By Neil Arnott. Seventh edition, edited by Alexander Bain and A. S. Taylor. New York: D. Appleton & Co. 1877. 12mo, pp. 873. $3.00.

Inventional Geometry: a Series of Problems, intended to familiarize the Pupil with Geometrical Conceptions, and to exercise his Inventive Faculty. By W. G. Spencer. With a Prefatory Note by Herbert Spencer. New York: D. Appleton & Co. 1877. Small 12mo, pp. 97.

Lessons from Nature, as manifested in Mind and Matter. By St. George Mivart. New York. 1876. 12mo, pp. 449. $2.00.

The Warfare of Science. By President A. D. White. New York: D. Appleton & Co. 1876. 12mo, pp. 151. $1.00.

Nature and Life. Facts and Doctrines relating to the Constitution of Matter, the New Dynamics, and the Philosophy of Nature. By Ferdinand Papillon. Translated from the second French edition. By A. R. Macdonough. New York: D. Appleton & Co. 1875. 12mo, pp. 363. $2 00.

The Chemistry of Light and Photography. By Dr. Hermann Vogel. With 100 Illustrations. (International Scientific Series.) New York: D. Appleton & Co. 1875. 12mo, pp. 286. $2.00.

The Five Senses of Man. By Julius Bernstein. (The International Scientific Series.) With 91 Wood-Cuts. New York: D. Appleton & Co. 1876. 12mo, pp. 304. $1.75.

The Nature of Light, with a General Account of Physical Optics. By Dr. Eugene Lommel. (The International Scientific Series.) With 188 Illustrations, and a Plate of Spectra in Chromo-lithography. New York: D. Appleton & Co. 1876. 12mo, pp. 356. $2 00.

Knowledge. Illustrated with Maps, Plans, and Engravings. Editors-in-chief, F. A. P. Barnard and Arnold Guyot. In 4 vols. Vol. iii. Lichfield—R. A. J. Johnson & Son. New York. 1877. 4to, pp. 1760. $10.00 for each volume.

Mines and Mineral Statistics of New South Wales, etc. Compiled by direction of the Hon. John Lucas, M. P., Minister for Mines. Also Remarks on the Sedimentary Formations of New South Wales. By the Rev. W. B. Clarke, etc. Sydney. 1875. 8vo, pp. 252.

The Art of Projecting. A Manual of Experimentation in Physics, Chemistry, and Natural History with the Porte-Lumière and Magic Lantern. By Prof. A. E. Dolbear. Illustrated. Boston : Lee & Shepard. 1877. 12mo, pp. 158. $1.50.

Thier Leben. Von A. E. Brehm. Erste Reihe. Die Handthiere. Heft i. Leipzig. 1877. 8vo. Profusely illustrated. For sale by B. Westermann & Co., New York.

Science Lectures at South Kensington. Photography. By Captain Abney. Sound and Music. By Dr. W. H. Stone. Kinematic Models. By Professor Kennedy. With Illustrations. London and New York : Macmillan & Co. 1876. 12mo. 20 cents each.

Manchester Science Lectures for the People. Eighth Series. 1876–77. What the Earth is Composed of. Three Lectures by Professor Roscoe. With Illustrations. London and New York : Macmillan & Co. 1876. 12mo, pp. 40. 20 cents.

Scientific Results of the Exploration of Alaska. By the parties under the charge of W. H. Dall, during the Years 1865–1874. Vol. i., No. 1. Introductory Note on the Marine Faunal Regions of the North Pacific, by W. H. Dall. Art I. Report on the Hydroids, by S. F. Clark, with Plates i–x. Art. II. On the Extension of the Seminal Products in Limpets, with Remarks on the Phylogeny of the Docoglossa, by W. H. Dall. December, 1876. W. H Dall, Smithsonian Institution. Washington, D. C. 8vo, pp. 34.

Bulletin of the Illinois Museum of Natural History. No. 1. Bloomington, Ill. December, 1876. 8vo, pp. 76.

Report upon New Species of Coleoptera collected by the Expeditions for Geographical Surveys west of the 100th Meridian. Lt. G. M. Wheeler in charge. By J. L. LeConte ; being extract from Appendix JJ of the Annual Report of the Chief of Engineers for 1876. Washington, D. C. 8vo, pp. 5.

Biographical Notice of the late Archibald R. Marvine. By J W. Powell. (From the Bulletin of the Philosophical Society of Washington, D. C.) 8vo, pp. 8.

Palæontological Bulletin, No. 23. On some Extinct Reptiles and Batrachia from the Judith River and Fox Hills Beds of Montana. By E. D. Cope. (Extracted from the Proceedings of the Academy of Natural Sciences of Philadelphia, December, 1876.) 8vo, pp. 20.

Half Hours with Insects. By A. S. Packard, Jr. Boston : Estes & Lauriat. 1877. 12mo, pp. 384. $2.50.

Forest Culture and Eucalyptus Trees. By Ellwood Cooper. San Francisco. 1876 12mo, pp. 204. $1.50.

GENERAL NOTES.

BOTANY.[1]

A List of the Lichenes found growing within Twenty Miles of Yale College.

1. Ramalina, *Ach.*, *De Not.*
   1. calicaris, *Fr.*, var. fraxinea, *Fr.*, on trees ; and var. farinacea, *Fr.* on rocks ; and var. canaliculata, *Fr.*
   2. rigida, *Ach.* On cedars (*J. Virginiana*), rare ; Short Beach, Branford ; *Alfred Barron.*

[1] Conducted by Prof. G. L. Goodale.

2. Cetraria, *Ach.*, *Fr.*
   1. Islandica, *Ach.* On dry ground in open woods.
   2. ciliaris, *Ach.* On old fence rails and dead trees.
   3. lacunosa, *Ach.*, and var. Atlantica, *Tuckerm.* On trees, etc. Not very common.
   4. aleurites (*Ach.*), *Th.*, *Fr.* Only one specimen found, on an old fence rail; Killingworth; *F. W. H.*
3. Evernia, *Ach.*, *Mann.*
   prunastri (*L.*), *Ach.* Killingworth, *F. W. H.;* Orange, *Prof. D. C. Eaton.* On rocks; not common.
4. Usnea, *Ach.*
   1. barbata (*L.*), *Fr.*, var. florida, *Fr.*, and var. rubiginea, *Michx.*, and var. dasypoga, *Fr.* The last var. forming long pendent gray clusters from dead limbs of our forest trees.
   2. angulata, *Ach.* Near Lake Saltonstall; *Prof. Eaton.* Not very common.
5. Alectoria (*Ach.*), *Nyl.*
   jubata (*L.*) var. chalybeiformis, *Ach.* Mostly on old fence rails.
6. Theloschistes, *Norm.*, *Tuckerm.*
   1. parietinus (*L.*), *Norm.*, and var. lychneus, *Schær.* On rocks and trunks of trees.
   2. chrysophthalmus (*L.*), *Norm.*, and var. flavicans, *Wallr.* On trunks and branches of trees: a pretty species with golden eyes.
   3. concolor (*Dicks.*), (*T. candelarius* (*Ach.*), *Nyl.*, var. *stellata*, *Nyl.*). On bark of trees.
7. Parmelia (*Ach.*), *De Not.*
   1. perforata (*Jacq.*), *Ach.*, and var. crinita, *Tuckerm.* Especially abundant on old stone walls.
   2. tiliacea (*Hoffm.*), *Floerk.* On stones and bark of trees.
   3. Borreri, *Turn.*, and var. rudecta, *Tuckerm.* On old fence rails; Killingworth; *F. W. H.*
   4. saxatilis (*L.*), *Fr.* Wallingford, *Alfred Barron;* Killingworth, *F. W. H.* On rocks.
   5. physodes (*L.*), *Ach.* Old rails, etc.
   6. colpodes, *Ach.* Wallingford; *A. Barron.*
   7. caperata (*L.*), *Ach.* Old fence rails and trunks of trees.
   8. conspersa (*Ehrh.*), *Ach.* Particularly abundant on exposed rocks and on old stone walls. Our most common species.
   9. olivacea (*L.*), *Ach.* On living and dead bark of trees.
8. Physcia (*Fr.*), *Th.*, *Fr.*
   1. aquila (*Ach.*), *Nyl.*, var. detonsa, *Tuckerm.* On rocks.
   2. pulverulenta (*Schreb.*), *Nyl.* Wallingford, *A. Barron;* Killingworth, *F. W. H.* On rocks and trunks.
   3. speciosa (*Wulf.*, *Fr.*), and var. hypoleuca, *Ach.*, and var. leucomela (*Eschw.*). On rocks, etc.

4. stellaris (*L.*), *Nyl.*, and var. hispida, *Fr.* On rocks and bark of trees.
5. obscura (*Ehrh.*), *Nyl.*, and var. ciliata, *Tuckerm.*, and var. erythrocardia, *Tuckerm.*, and var. adglutinata, *Schær.* On rocks; the latter var. abundant on currant bushes (*Ribes rubrum*).

9. Umbilicaria, *Hoffm.*
1. pustulata (*L.*), *Hoffm.* According to my observations, this species is most common on high rocks in river bottoms, where it is exposed to the water in times of freshets.
2. Dillenii, *Tuckerm.* Same habitat as above.
3. Muhlenbergii (*Ach.*), *Tuckerm.* On rocks.

10. Sticta (*Schreb.*), *Delis.*
1. crocata (*L.*), *Ach.* On trunks and rocks.
2. quercizans (*Michx.*), *Ach.* On rocks; not common. Killingworth, *F. W. H.;* Orange, *F. W. H.*
3. pulmonaria (*L.*), *Ach.* On trunks of trees.
4. glomerulifera (*Lightf.*), *Delis.* On rocks.

11. Nephroma, *Ach.*
1. lævigatum, *Ach.* Killingworth and Orange; *F. W. H.* Not very common.

12. Peltigera (*Hoffm.*), *Fée.*
1. aphthosa (*L.*), *Hoffm.* Moist, mossy banks, among woods.
2. canina (*L.*), *Hoffm.*, and var. spuria, *Ach.* On damp ground.
3. polydactyla (*Neck.*), *Hoffm.* Damp ground in woods, etc.
4. rufescens (*Neck.*), *Hoffm.* Damp ground in woods, etc.

13. Pannaria, *Delis.*
1. lanuginosa (*Ach.*), *Koerb.* Killingworth; *F. W. H.* Trunks and earth.
2. lurida (*Mont.*), *Nyl.* On the ground and rocks.
3. tryptophylla, *Ach.*, *Mass.* On basalt; Hampden; *Prof. Eaton.*
4. microphylla (*Sw.*), *Del.* Trunks, etc.
5. leucosticta, *Tuckerm.* Trunks, banks, etc. Killingworth; *F. W. H.*
6. molybdæa (*Pers.*), *Tuckerm.*, var. cronia, *Nyl.* Trunks, rocks, etc. Killingworth; *F. W. H.*

14. Ephebe, *Fr.*
pubescens (*Ach.*), *Fr.* West Rock; *Prof. Eaton.*

15. Collema (*Hoffm.*), *Fr.*
1. flaccidum, *Ach.* Bark, especially of the cedar (*J. Virginiana*).
2. nigrescens (*Huds.*), *Ach.* Same habitat as above.

16. Leptogium, *Fr.*
1. lacerum (*Sw.*), *Fr.* Moist rocks, etc.
2. pulchellum (*Ach.*), *Nyl.* Moist rocks, earth, etc.
3. tremelloides (*L.*), *Fr.* Earth and rocks.
4. chloromelum (*Sw.*), *Nyl.* Moist rocks.

5. myochroum (*Ehrh.*), *Schær.*, var. saturninum (*Dicks.*), *Tuckerm.* Moist rocks, etc.

17. Hydrothyria, *Russell.*
    venosa, *Russell.* Rivulets; Mt. Carmel and West Rock; *Prof. Eaton.*

18. Placodium (*D. C.*) *Naeg.*, and *Hepp.*
    1. elegans, *D. C.*) Trunks of trees, etc.
    2. vitellinum (*Ehrh.*), *Hepp.* Wallingford; *A. Barron.*
    3. cerinum (*Hedw.*), *Naeg.*, and var. hæmatites, *Fr.*
    4. aurantiacum (*Lightf.*), *Naeg.* Trunks.

19. Lecanora, *Ach.*, *Tuckerm.*
    1. muralis (*Schreb.*), *Schær.* Wallingford; *A. Barron.*
    2. pallescens (*L.*), *Fr.* Rocks; Killingworth; *F. W. H.*
    3. tartarea (*L.*), *Ach.*, and var. frigida, *Ach.* Rocks.
    4. subfusca (*L.*), *Ach.* On trees and rocks, mostly the latter.
    5. albella, *Ach.* (*L. pallida* (*Schreb.*), *Schær.*), and var. cæsio-rubella (*Ach.*). On living bark.
    6. varia (*Ehrh.*), *Fr.* On old board and rail fences.
    7. cinerea (*L.*), *Fr.* Stones, etc.
    8. cervina (*Pers.*), *Sommerf.*, var. discreta, *Fr.*, and var. privigna, *Ach.*, and var. clavus, *D. C.* Killingworth; *F. W. H.* Rocks and stones.

20. Rinodina, *Mass.*, *Stizenb.*
    1. sophodes (*Ach.*), var. confragosa, *Nyl.* Rocks and stones. Killingworth, *F. W. H.*; Wallingford, *A. Barron.*
    2. constans (*Nyl.*), *Tuckerm.* Wallingford; *A. Barron.*

21. Pertusaria, *D. C.*
    1. pertusa (*L.*), *Ach. s. Por.* Trunks of trees and rocks.
    2. leioplaca (*Ach.*), *Schær.* Trunks and rocks.
    3. velata (*Turn.*), *Nyl.* Mostly on trunks.
    4. multipuncta (*Sm.*), *Nyl.* Trunks and branches.
    5. pustulata (*Ach.*), *Nyl.* Trunks and branches.
    6. globularis, *Ach.* Rocks and trunks.

22. Conotrema, *Tuckerm.*
    urceolatum (*Ach.*), *Tuckerm.* Wallingford, *A. Barron*; Killing worth, *F. W. H.* On bark of trees, especially on maples (*Acer rubrum* and *A. saccharinum*).

23. Urceolaria (*Ach.*), *Flot.*
    1. scruposa (*L.*), *Ach.* Wallingford; *A. Barron.*
    2. actinostoma, *Pers.* Sent from Wethersfield to *Mr. Willey.*

24. Stereocaulon, *Schreb.*
    paschale, *Laur.* On rocks at Mt. Carmel, etc.

25. Cladonia, *Hoffm.*
    1. papillaria (*Ehrh.*), *Hoffm.* On dry hills. Killingworth; *F. W. H.*
    2. alcicornis, *Fr.* Rocks and earth.

3. pyxidata (*L.*), *Fr.* Earth.
4. cariosa (*Ach.*), *Spreng.* Earth.
5. fimbriata (*L.*), *Fr.*, and var. adspersa, *Tuckerm.* Earth, etc.
6. gracilis (*L.*), *Fr.*, and var. verticillata, *Fr.* Earth.
7. mitrula, *Tuckerm.* Wallingford; *A. Barron.* Earth.
8. furcata (*Huds.*), *Fr.*, and var. cristata, *Fr.*, and var. racemosa, *Flk.*, and var. lacunosa, *Flk.* Dry hills and open woods.
9. rangiferina (*L.*), *Hoffm.*, and var. sylvatica, *L.*, and var. alpestris, *L.* Dry hills and open woods.
10. uncialis (*L.*), *Fr.* Hilly ground among woods.
11. lacunosa, *Del.* Hilly ground among woods.
12. cornucopioides (*L.*), *Fr.* Rich ground and on rotten stumps.
13. cristatella, *Tuckerm.* Mostly on decayed stumps and fence rails.

26. Bæomyces, *Pers.*, *Nyl.*
 roseus, *Pers.* Sandy banks.

27. Biatora, *Fr.*
1. vernalis (*L.*), *Th.*, *Fr.* Earth and trees.
2. russula (*Ach.*), *Mont.* Killingworth; *F. W. H.* Trees; exceedingly rare.
3. sanguineo-atra (*Fr.*), *Tuckerm.* Moist banks and trunks.
4. exigua (*Chaub.*), *Fr.* Bark of trees.
5. rubella (*Ehrh.*), *Rabenh.*, and var. muscorum, *Nyl.* Moist banks.

28. Lecidea (*Ach.*), *Fr.*
1. albo-cœrulescens, *Fr.* On rocks and stones.
2. contigua, *Fr.*, *Nyl.* On rocks, etc.
3. spilota, *Fr.* Wallingford; *A. Barron.*

29. Buellia, *De Not.*, *Tuckerm.*
1. lactea, *Mass.* Wallingford; *A. Barron.*
2. lepidastra, *Tuckerm.* On rocks. Wallingford, *A. Barron;* Killingworth, *F. W. H.*
3. parasema (*Ach.*), *Koerb.* Trunks and branches.
4. myriocarpa (*D. C.*), *Mudd.* Rocks, trees (?), etc. Killingworth; *F. W. H.*
5. petræa (*Flot.*), *Tuckerm.* On rocks and stones. Killingworth; *F. W. H.*

30. Opegrapha (*Humb.*), *Ach.*, *Nyl.*
 varia (*Pers.*), *Fr.*

31. Graphis (*Ach.*), *Nyl.*
 scripta (*L.*), *Ach.*, and var. limitata, *Schær.* Bark of trees. Killingworth, *F. W. H.;* Wallingford, *A. Barron.*

32. Arthonia, *Ach.*, *Nyl.*
1. astroidea, *Ach.*, *Nyl.* Bark of trees. Killingworth; *F. W. H.*
2. punctiformis, *Ach.* Bark of trees. Killingworth; *F. W. H.*
3. tædiosa, *Nyl.* Bark of trees, and rocks (?). Killingworth; *F. W. H.*

33. Mycoporum (*Flot.*), *Nyl.*
    pycnocarpum, *Nyl.* Killingworth; *F. W. H.*
34. Acolium (*Fée.*), *De Not.*
    tigillare (*Ach.*), *D. N.* Wallingford; *A. Barron.*
35. Calicium, *Pers.*, *Fr.*
    subtile, *Fr.* On old boards and fence rails. Killingworth; *F. W. H.*
36. Endocarpon, *Hedw.*, *Fr.*
    miniatum (*L.*) *Schær.*, and var. complicatum, *Schær.*, and var. aquaticum, *Schær.* On submerged stones in rivulets; also on damp exposed rocks.
37. Trypethelium, *Spreng.*, *Nyl.*
    virens, *Tuckerm.* Wallingford; *A. Barron.*
38. Pyrenula (*Ach.*), *Naeg.*, and *Hepp.*
    1. punctiformis (*Ach.*), *Naeg.* On trunks of trees. Killingworth; *F. W. H.*
    2. nitida, *Ach.* On trunks of trees. Wallingford, *A. Barron;* Killingworth, *F. W. H.* — F. W. Hall.

Minot's New England Birds; Additions. — In my late work on New England Birds, by carelessly overlooking one of my own memoranda, I omitted mention of the Swallow-tailed Kite (*Nauclerus forficatus*), once *seen* near Whately, Mass., of the melanistic Swainson's Buzzard (*Buteo Swainsoni, insignatus*), *captured* in Massachusetts, and of the Arkansas Flycatcher (*Tyrannus verticalis*) recorded from Plympton Me. *Helminthophaga pinus* is a summer resident at Saybrook, Conn. (*Purdie.*) December 1876. — H. D. Minot.

Large Trunks of Kalmia latifolia. — It is well known that this *Kalmia* attains its maximum size in the southern Alleghanies. Probably nothing upon record exceeds or even equals the following measurements of the girth of two trees which grow, along with others not very much smaller, in the bottom of a dell back of Cæsar's Head, on the extreme western border of South Carolina. One trunk, at a foot or so from the ground,measured four feet one and a quarter inches in circumference, and, rising without division, maintains a size approaching this and gradually lessening, for six or seven feet.

Another trunk measured three feet four inches in girth above the first limb or fork; below it, at nearly one foot from the ground, it measured four feet and four inches. The measurements were taken September 2, 1876, by Dr. George Engelmann, William M. Canby, and Asa Gray.

The Production of Starch in Chlorophyll-Granules. — Böhm asserts that if light is sufficiently intense to induce assimilation in green leaves, it has the power to cause an immediate transfer of starch *from* the stem, where elaborated matters may be stored, *to* the chlorophyll-granules. For this reason he believes that many observations hitherto made in regard to the immediate production of starch from carbonic

dioxide in chlorophyll are untrustworthy. Such experiments should be made upon plants which have no starch already stored up, or upon detached leaves which contain no starch.

THE EFFECT OF FROST ON CHLOROPHYLL-GRANULES. — Haberlandt states that the granules except in evergreens undergo changes at 4° to 6° C. The granules thus affected contain cavities (vacuoles), become rent on the outside, and aggregate into larger or smaller masses. The granules which contain starch are more easily destroyed by frost than those which contain none. The chlorophyll in the palisade tissue (the denser parenchyma) is more easily injured than that in the spongy tissue, and the latter than that in the guardian cells of the stomata.

DICHOGAMY OF AGAVE. — The flowering of a plant of *Agave yuccæfolia* Red. (Bot. Mag. t. 3213), in a private collection near Boston, has given abundant opportunity to watch the development of its flowers, and to confirm in regard to this species Engelmann's statement (Notes on Agave. Transactions of the Academy of St. Louis, vol. 3, December, 1875), that the flowers of this genus are "vespertine or nocturnal, and *proteranderous*."

Agave yuccæfolia must be referred to Engelmann's second section, *Geminifloræ*, although on our plant the lower flowers alone are borne in pairs. The forty uppermost flowers of the spike spring singly each from the axis of a bract, and in this approach his first section, *Singulifloræ*. The production of solitary flowers on the upper portion of the spike is possibly abnormal; but should this prove a constant character a slight modification of Engelmann's sections of the genus will become necessary. In the figure in the *Botanical Magazine* the arrangement of the flowers is not distinct; but in the accompanying description we read, "Flowers *often* two together."

The scape first made its appearance on November 1st, and continued to grow until January 6th, when it had attained a height of ten feet, the first flowers opening about five P. M. on that day. Shortly after the opening of the flower the filaments attain their full development, and are exserted 9″ beyond the lobes of the perigone. The style at this time is barely exserted and much reflexed, the stigma bearing these papillose lines radiating from its centre down the middle of each of the three lobes. A little before eight o'clock on the morning after the opening of the flower, the tube of the perigone is entirely filled with the honeyed secretion, which is slightly odoriferous, sapid, straw-colored, and very abundant. At ten P. M. of the second day, or seventeen hours after the opening of the flower, the anthers burst. At this time the style has elongated and partially straightened until the stigma, over which the papillæ have not as yet extended, is placed just above the introrse anthers, and in such a position that none of the pollen discharged from them can reach its surface. During the third day the style continues to elongate and straighten. On the morning of the fourth day the style is

found to be perfectly erect and exserted 16′′ beyond the lobes of the perigone, or 7′′ beyond the stamens at their fullest development. The papillæ have now extended laterally over the entire surface of the stigma, from which is freely secreted a clear, colorless, sticky liquid.

The stigma is now perfectly developed, and ready to receive the pollen grains;[1] but it is more than forty-eight hours since the anthers discharged their pollen, and for the last twelve they have hung useless and effete, and are already beginning to drop off. It is evident, then, that flowers of our *Agave* must depend for fertilization either on the very uncertain chance of some of the pollen discharged from the anthers of the upper flowers, dropping just at the right moment on the developed stigmas of the lower and older ones, or on the visits of some nocturnal insect, on the search for the abundant and attractive secretions contained in the tube of the perigone. Fertilization of the lower flowers is probably secured by both these agencies. Those placed higher up on the scape can only be made productive by pollen brought from other plants and placed on their stigmas at the moment of their maturity. — C. S. SARGENT.

PHYLLOTAXIS OF CONES.[2] — I wish here to supplement an article which appeared in the American Naturalist in August, 1873. Mention is there made of finding cones of several species in which the phyllotaxis of part of them consists in opposite leaves more or less spirally arranged. The fraction expressing the arrangement for scales on such cones falls into the series $\frac{2}{4}$, $\frac{2}{6}$, $\frac{4}{10}$, $\frac{6}{16}$, $\frac{10}{26}$, etc. One cone of a European larch was recorded having three, six, and nine spirals, and falling into the series $\frac{3}{6}$, $\frac{3}{9}$, $\frac{6}{15}$, $\frac{9}{24}$, $\frac{15}{39}$, etc., or having the scales in whorls of three.

This summer, on examining about three pecks of cones from one tree of the European larch, three more cones were found in which the arrangement of scales falls into the series beginning with decussate whorls of three. I have now found a single cone on which there are four spiral whorls in one direction, and four and eight in the opposite direction. The fraction expressing its phyllotaxis is $\frac{8}{24}$, and falls into the series beginning with decussating verticels of four, namely, $\frac{4}{8}$, $\frac{4}{12}$, $\frac{8}{20}$, $\frac{12}{32}$, $\frac{20}{52}$, etc. Some of these cones were exhibited with the scales marked in ink.

In reply to some questions of Professor Morse, as to whether all the cones had a phyllotaxis like the examples mentioned, Professor Beal remarked that the arrangement of most cones of the European larch was that of alternate leaves, and was expressed by the fraction $\frac{8}{21}$, falling into the series $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, etc. The fraction for a few cones with al-

[1] I have failed to detect in *A. Yuccæfolia* any opening between the lobes of the stigma at its maturity as noticed by Engelmann in *A. Virginica*, and by Jacobi (Ag. 310) in *A. Gœppertiana*.

[2] Read in Buffalo before the American Association for 1876 by Professor W. J. Beal.

ternate leaves was $\frac{8}{29}$, falling into the series $\frac{1}{3}$, $\frac{1}{4}$, $\frac{2}{7}$, $\frac{3}{11}$, $\frac{5}{18}$, $\frac{8}{29}$, etc. In a few cones with opposite scales it was $\frac{10}{26}$, falling into a series given above. In a few others in whorls of three the fraction was $\frac{6}{15}$; in one cone the scales were in whorls of four. How many additional forms may be found on examining large numbers of specimens he did not know, but presumed we had not yet found them all. On all the trees examined, he had found the spiral whorls of the scales to vary; that certain spirals ran to the right in part of the cones, and to the left in about the same number on each tree in each year; that in all cases examined there was quite a variety in the phyllotaxis of each tree. So he had found it on many herbaceous plants.

As we might expect, there was no one, fixed, undeviating plan for the arrangement of all the leaves on plants of any species; we should find exceptions to our rules if we examine specimens enough.

BOTANICAL NOTES FROM RECENT PERIODICALS. — *Flora.* (No new numbers have been received since our last review.)

Botanische Zeitung, No. 43. O. Behrendsen, Contributions to the Flora of Hungary. No. 44. E. Stahl, On the Artificial Formation of Protonemata from the Sporogonium of Musci. (In true mosses the protonema is a tubular outgrowth from the spore. This minute tube elongates by growth at the tip, and afterwards branches. Pringsheim has shown (1876) that protonematous threads may be produced from the severed fruit-stalk of mosses. This is now confirmed by Stahl, who also shows its bearing upon alternation of generation, and examines its relations to Dr. Farlow's interesting discovery of an asexual growth on the prothallus of ferns.) Cramer, Note claiming Priority of Discovery respecting Reproduction in *Ulothrix.* Reports of Societies. Nos. 45 and 46 previously noticed. No. 47. Fickel, On the Anatomy and Development of the Seed-Coats of some *Cucurbitaceæ.* Continued in Nos. 48, 49, and 50. No. 51. Dr. Drude, On the Separation of the Palms of America from those of the Old World.

ZOÖLOGY.

A NEW SUB-KINGDOM OF ANIMALS. — Prof. E. Van Beneden in his elaborate "Recherches sur les Dicyemides, Survivants actuels d'un Embranchement des Mésozoaires" proposes a new sub-kingdom of animals. In 1830 Krohn observed the presence in the liquid bathing the spongy bodies (perhaps renal organs) of different species of Cephalopods certain filiform bodies, covered with vibratile cilia and resembling infusoria or ciliated worms. They were called *Dicyema* by Kölliker, who, with others, considered them as intestinal worms; Van Beneden claims that they have no general body-cavity. The body is formed (1) of a large axial cylindrical or fusiform cell, which extends from the anterior extremity of the body, enlarged into a head, to the caudal extremity; (2) of a single row of flat cells forming around the axial cell a sort of

simple pavement epithelium. All these cells are placed in juxtaposition like the constituent elements of a vegetable tissue. There is no trace of a homogeneous layer, of connective tissue, of muscular fibre, of nervous elements, nor of intercellular substance. There is only between the cells a homogeneous (*unissante*) substance, as between epithelial cells. The axial cell is regarded as homologous with the endoderm of the higher animals (*Metazoa*). He designates as the ectodermic layer the cells surrounding the large, single axial cell. There exists no trace of a middle layer of cells. We discover no differentiated apparatus; all the animal and vegetative functions are accomplished by the activity of the ectodermic cells and of the axial cell. On account of these characteristics Van Beneden regards these organisms as forming the type of a new branch of the animal kingdom which he distinguishes as *Mesozoa*.

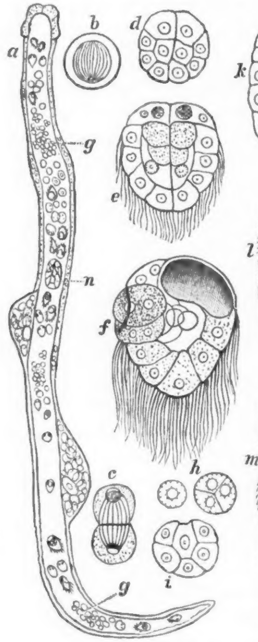
Each species of *Dicyema* comprises two sorts of individuals differing externally, one (the *Nematogene*) producing vermiform embryos, the other (*Rhombogene*) infusoriform young. The Nematogenes produce germs which undergo total segmentation, and assume a *gastrula* condition. After the closure of the blastopore the body elongates, and the worm-like form of the adult is finally attained, as they pass through the body-walls of the parent.

The germs of the Rhombogenes arise endogenously in special cells lodged in the axial cell and called "germigenes." The germ-like cells undergo segmentation, and then form small spheres which become infusoriform embryos. The worm-like young is destined to be developed and live in the Cephalopod where it has been born, while the infusorian-like young probably performs the office of disseminating the species; it transmits the parasite of one Cephalopod to another.

This work is also an important contribution to histology, particularly to the subject of cell-division. Says Van Beneden, "the recent researches of Auerbach, of Bütschli, of Strasburger, of Hertwich, and those that I have published, have established the fact that the division of a cellule, that is to say, the multiplication of the cellular individuality, is the resultant of a long series of complex phenomena, accomplished in a determinate order, and having their seat as much in the nucleus as in the substance of the cell."

Finally, Van Beneden places in his branch of *Mesozoa* the hypothetical *Gastræades*, which term he applies to (*gastrula*-like) organisms formed of two kinds of cellules, some ectodermic, others endodermic, in which the endoderm is formed by invagination. He calls *Planulades*, those hypothetical Mesozoa which are formed from a many-celled sphere constituted like a *Magosphæra* (Haeckel) and in which the two cellular layers are developed by delamination. He therefore divides the animal kingdom into three primary groups, that is, the *Protozoa*, the *Mesozoa*, and the *Metazoa*.

Our illustration will convey some idea of these organisms. Fig. *a* represents *Dicyemella wageneri*; *g*, germigenes; *n*, the nucleus of the axial cell; *b*, the spherical germ of *Dicyemella* with its striated nucleus;



(Fig. 24.) DICYEMELLA AND YOUNG.

c, the same beginning to undergo self-division; *d*, final stages of self-division (morula); *e* and *f*, infusoriform embryo; *h*, germs of the vermiform embryos of *Dicyema typus*; *i*, gastrula of the same; *k*, *l*, *m*, *o*, different stages of vermiform larvæ of *Dicyema typus*.

ANTHROPOLOGY.

Archæological Exchange Club. — A want which American anthropologists have long felt is about to be supplied in the formation ot the "Archæological Exchange Club." in connection with the "American Anthropological Association." The conditions of membership are given in a circular to be obtained from Stephen D. Peet, Secretary, Ashtabula, Ohio. The advantages to be derived by members are twofold: first, they will have their papers laid before every prominent archæologist in the country; secondly, they will be supplied with many publications which could be obtained in no other way. It is to be hoped that each one interested in this branch of science will assist in the establishment of the club by becoming a member. The benefits occurring from such

coöperation will prove great incentives to study and research. — E. A. Barber.

Anthropological News. — In the Report on Indian Affairs for 1875, Dr. Thomas Foster announces the forthcoming of a first volume of his report on all the Indian Tribes of the United States. The author has prepared an elaborate memoir on the Winnebago tribe. Pending the appearance of this volume he has commenced the issue of a sheet entitled *Foster's Indian Record and Historical Data*, the first number appearing under date of November 30th. The object of the *Record* is to submit the plan of the work to "friendly criticism" before the more costly and elaborate production appears. Fully agreeing with the author that such a work would be a worthy memorial of the race, if properly executed, we venture to offer some observations, certainly in no unfriendly spirit. The proof-reading of the *Record* is miserable; the mixing up of sundry fonts of type in the columns gives the appearance of a type-founder's circular; and the absence of literary taste detracts from the real and solid merit in the work. These, however, are venial faults, and doubtless will be rectified. The author commences his true work with the alphabet, and lays down several canons, some of which are decidedly untenable. The chief objection lies against the alphabet itself, which not only differs from Turner and Whipple's, Whitney's quoted by Gibbs, and Major Powell's in substituting new vocables for theirs, but also in calling for special fonts of type and uncommon logotypes which cannot be reproduced excepting at the printing-office where Mr. Foster's works are published. Foreign students accustomed to study the vocabularies collected by the Gibbs circular will have to re-write them for comparison. It is not necessary to take up each letter separately, since we object to the whole alphabet. The monographs will be noticed in a future number.

Those who wish a rich treat in philology will do well to read Dr. Richard Morris's presidential address before the London Philological Society, May 19, 1876. After recounting the labors of the society, and reviewing the work done on English dialects, the president called to his assistance the following specialists: Dr. J. Muir and Professor Eggeling, on Sanskrit; M. Chev. E. de Ujfalvy, on the Ugro-Finnish languages; Dr. Ad. Neubauer, on Talmudical and Rabbinical literature; the Rev. A. H. Sayce, on Etruscan; R. N. Cust, Esq., on the non-Aryan languages of India; Dr. J. Hammond Trumbull, on the North American Indian languages; M. Edouard Naville, on the latest researches of Egyptologists; Dr. Kölbing, on Teutonic languages. Dr. Trumbull, in addition to reciting the labors of those scholars with whom we are already familiar, and announcing several forthcoming works, quotes from a private letter from Major J. W. Powell, in which the following classification is recommended for the Shoshoni or Numa languages: —

Wa-shak'-i, Shoshoni proper.

Dialect: *Ta-sau'-wi-hi*, Shoshonis of Central Nevada.

Ko-man'-tsu, Comanches.

Pan-ai'-ti, Bannacks.

Pa-vi-o'-tso, Pah-Utes, or Pai Utes of Western Nevada.

Dialect: *Pan'-a-mint.*

Go-si-ute (of Nevada and Utah).

U'-ta-ats, Utes.

Dialects: *Mu-a'-tsu* (Southern California, Northern Mexico.)

Kai-vav'-it (Pai-Utes of Northern Oregon.)

Nu-a'-gun-tit (Pai-Utes of Southern Nevada.)

Tan'-ta-waits, or Chemehuevis.

Shi'-nu-mo. In six (of the seven) Pueblos in Tusayan, or Moqui, Northern Arizona.

A full account of the International Congress at Buda-Pesth will be found in Nos. 10 and 11 of the *Matériaux*. The principal part of the discussions referred to the relation between the stone and the metal age of Hungary and of the rest of Europe. Especial notice was taken of the abundance of copper articles found in Hungary.

The year just past has been rich in its gifts to classical archæology. The discoveries and published accounts of Wood at Ephesus, di Cesnola at Cyprus, Schliemann at Mycenæ, Parker at Rome, and the German explorers at Olympus are especially noticeable. Mr. Wood's results are published in Discoveries at Ephesus; Longmans & Co., 1877. Di Cesnola's latest rich harvest of gems, of jewelry and ornaments of gold, silver, and bronze, and of fictile ware, found at Kourium, on the south side of Cyprus, has been purchased for the Metropolitan Museum of Art, for the sum of $66,000. *The Academy* speaks disparagingly of our archæological students, but, no doubt, these treasures will stir up some fresh enthusiasm. Dr. Schliemann, in his excavations at Mycenæ, claims to have fallen on the tomb of Agamemnon. At least the treasure-trove proves his last discovery to be the most lucky of all, and promises to add to our knowledge of a period previously illustrated only by a few specimens in the British Museum. The fruits of the excavations at Rome may be gathered from two publications by Mr. John Murray for Mr. J. H. Parker, The Flavian Amphitheatre and Historical Construction of Walls in Rome and from The Catacombs of Rome, etc., by the Rev. W. H. Withrow: Hodder and Stoughton.

Abbé Ducrost and M. Arcelin have just finished the exploration of the detritus at the foot of the cliff at Solutré, and have found it to consist of five zones. The first, or lowest, rests on the lias and exhibits bones of extinct animals and flint flakes accumulated at points, forming kitchen-middings. The second zone contains bones of the horse, in such numbers that the individuals may be counted by hundreds of thousands. The third zone is nearly sterile. The fourth zone commences the "age of the reindeer" proper, with the refuse of cooking, and remains of dwellings, in great abundance. Here the horse and the reindeer predominate. The fifth zone is made up of modern débris. The authors

find in the results of their digging confirmation of the superposition of the Mousterian upon the Solutréan epoch, by M. G. de Mortillet.

In *Matériaux*, 11th number, Mr. Valdemar Schmidt's paper on Comparative Studies upon Funeral Rites in Prehistoric Times in Europe is reviewed. During the stone age inhumation was in use in nearly all these countries. Traces of cremation are observed in certain regions in the tombs of that age, but it can be proved that these sepultures belong to an epoch not far removed from the age of bronze. During the latter age, incineration predominated in the east of Central Europe, and in the north; but in the west inhumation was more frequent. In Scandinavian countries, two periods can be distinguished; the former, where the bodies were inhumed, the latter, where they were burned. Passing to the age of iron, anterior to the Roman period, we see inhumation practiced in Greece, cremation in Italy. In the west of Europe, inhumation predominated; in the east, incineration; in the centre, the two rites coexisted. In Scandinavia, this epoch does not exist. In the Roman epoch, they burned the corpses at Rome, in the provinces, and in most other countries; but at the end of the reign of the Antonines, inhumation was recommended, and this method was propagated everywhere, even beyond the Roman empire. Since then there has been no incineration, excepting in Slavonic countries, and among the Saxons in the north of Germany. This rite did not disappear until the prevalence of Christianity. Dr. Schmidt thinks that the custom of cremation was brought into Europe by the Aryans.

In the same number of *Matériaux*, P. Fischer contributes a very valuable paper on the recent and fossil shells found in the caverns in the south of France, and in Liguria. In gathering up these results the author has been assisted by MM. Lartet, Massenat, Mortillet, Piette, and Rivière. The authorities on the subject are copiously given.

The opening of the School of Anthropology, established a year ago in Paris, took place November 15th. M. Broca, director of the course, delivered the opening address, explaining the limits of anthropology and its relations to other subjects. Anthropology studies the individual, that it may know the many; medicine studies the many that it may heal the individual; and thus with other ancillary sciences. Anthropology is the natural history of the human race. The course, as established, is as follows: —

Anatomical Anthropology, P. Broca.

(1.) Comparison of man with the higher mammals.

(2.) Comparative anatomy of races.

(3.) Craniology.

Biological Anthropology. P. Topinard.

(1.) Physical and physiological characters of living men.

(2.) Anthropometry.

Ethnological Anthropology. Eugene Dally.

Classification of races, divisions, and relationships.

Prehistoric Anthropology. G. de Mortillet.

(1.) Human palæontology.

(2.) Prehistoric archæology.

(3.) Determination of human remains by archæological data.

Linguistic Anthropology. M. Hovelacque.

General characteristics, classification, and division of languages.

In *Archivio per l'Antropologia*, etc., Dr. Luigi Pagliani publishes an interesting memoir upon the influence of human environment upon the development of the individual, taking as his motto Quetelet's sentence, "The development of the mature man is trammeled by the special conditions in which the poor infants find themselves; the laws of nature are combated by the influences of our social organization without recurring to force. It depends in some sort upon the government to have the people large or small, more or less vigorous." M. Pagliani treats of his subject under the four following heads: —

(1.) The influence of unfavorable conditions of life on the physical development of men.

(2.) Influence of the amelioration of life upon organisms at first subjected to unfortunate conditions.

(3.) Influence of conditions somewhat favorable to life upon human physical development.

(4.) Relation between the physical development of the male and the female sex under diverse conditions.

(5.) Activity of physical development in the years which precede and follow the age of puberty in the two sexes, and under special conditions.

Five parts of Mr. Herbert Spencer's Descriptive Sociology are now in print, namely: (1.) English, (2.) Ancient American Races, (3.) Lowest Races, Negritos, Polynesians, (4.) African Races, (5.) Asiatic Races. Volume I. of The Principles of Sociology is also announced by the same author. — Otis T. Mason.

Note. In order to make the monthly anthropological notes, kindly prepared for the Naturalist by Professor Mason, as complete as possible, authors of books, pamphlets, or newspaper articles relating to anthropology, published either in this country or Europe, are invited to send copies to Prof. O. T. Mason, Columbian College, Washington, D. C. — Editor American Naturalist.

GEOLOGY AND PALÆONTOLOGY.

MM. Gaudry and De Saporta on the Palæontology of the Western Territories.[1] — I have readwith much interest the explanations in your letter relating to the explorations of the western Territories. I see that the works of Mr. Lesquereux on vegetable palæontology appear to you to be of great importance. As to myself I eagerly pursue the researches made in regard to fossil vertebrates. I think like yourself that the results of the explorations directed by Professor Hay-

[1] In a letter to Count de Saporta.

den are to be counted among the most remarkable acquisitions of modern palæontology; naturalists are compelled to recognize gratefully the labors of that great explorer who has gathered so many new facts, and who has so well understood the art of selecting such able assistants. From my stand-point, it is not the discovery of strange and hitherto unknown forms which produces the highest interest in Dr. Leidy's works on mammiferous fossils, but the discovery of the neighboring forms of our European mammiferous fossils, for they show us the ties between the species of the Old and the New World; also they let us hope that we may be able to understand and discover more easily the connections of the beings of the geological ages.

Dicotyles arcuatus looks very much like *Chæromorus* of the middle Miocene of Sausan; *Hyopsodus* has molars like the *Hyægulus* of the superior Eocene of Débruge; *Microsyops* is related to the *Adapis*, a genus partly lemurian, partly pachydermatous, which under the name of *Adapis*, sometimes under that of *Paleocolemus* and also of *Aphelotreium*, has left numerous débris in the superior Eocene, and in the lowest Miocene. *Merychippus* looks much like *Protohippus*, and the latter itself seems to be a *Hipparion* of the Leberon, the island of the superior molars of which has been transformed into a peninsula. *Archæotherium* is nothing else than the *Entelodon* of our inferior Miocene of Bouzon. Concerning dentition, *Paleosyops*, *Limnohyus*, and *Titanotherium* resemble a good deal the *Chalicotherium*; this similitude of forms has struck me the more, as it shows itself in the species, alike common in America and Europe; the *Chalicotherium* is found in Europe in the inferior Miocene of phosphorites, the middle Miocene of Sausan, and the superior Miocene of Eppelsheim. *Hyrachius* presents us a rare example of the passage from the *Lophiodon* to the tapir; concerning the distinctive marks of the latter there appears a last superior pre-molar which is simplified, and provided with one single internal denticule, like the *Lophiodon*. According to my judgment, the animal lately discovered by M. Filhol in the phosphorites of Querez, under the name of *Tapirus priscus*, is a genuine *Hyrachius*. The *Hyracodon* is one more link between the *Rhinoceros* and the *Paleotherium*; it is the former which has the dental formula of the *Paleotherium*. The *Œlurogale* of the phosphorites described by M. Filhol is the immediate ally of Dr. Leidy's *Dinictis*. There are found other examples of intermediate forms in the publications of the American savants. If we add, to judge from the plates of Dr. Leidy, the discoveries in the western Territories of the *Amphicyon*, *Canis*, *Pseudælurus*, *Mæhæcodus*, *Hyænodon*, *Hipparion*, *Anchitherium*, *Rhinoceros*, *Hyopotamus*, *Mastodon*, very closely related to the species we find in France, it becomes singularly probable that the west of North America and Europe have been in connection during the Miocene period. How could such a thing have happened, if, as able geologists believe, the Atlantic Ocean has scarcely changed its place?

Did the communication take place on the side of the Pacific? There are many mysteries still to be solved. The fine researches of American savants open new horizons for our thoughts; being so distant they still appear a little misty, but doubtless they will come forward one day and inaugurate the great era of palæontology.

Will you please, dear friend, accept the expression of my most sincere sentiments. — ALBERT GAUDRY, Professor of Palæontology in the Museum of Natural History.

Professor Hayden: Dear and Honored Sir, — For many months I have lived in communication of thought with you, and the happy intermedium of our common friend, Lesquereux, binds us to each other. Your name now is so widely known in Europe, and it is so intimately connected with the splendid discoveries which palæontologists owe to your explorations, that I have double pleasure in writing to you. We watch attentively the results of your undertaking, and, for myself, I may say that the rich harvest of Cretaceous and Tertiary fossil plants gathered under your direction have opened before me such broad horizons, that I am never tired of considering them. I have successively received the publications, reports, and fine maps recently published, — thanks to your perseverance. I offer you my most sincere wishes for the continuation of your work.

The richness of your deposits is incalculable, but it does not surprise me, and I believe that you will be able greatly to increase your treasure by new researches. Here in Europe, upon a cut-up continent which for a long time has rather been an archipelago than a wide region, we have small lacustrine formations, corresponding with other lakes of small extent, also, and these formations are often very rich in fossils. But this abundance is restricted, though real, for the extent of the formation is proportional to that of the land surface wherein they are distributed. But in America all is on a very large scale: the rivers, the plains, the lakes, the mountains, the frame itself is grand; and this aspect is the result of ancient causes which have influenced the nature and the thickness and extent of the formations.

You will therefore discover in these deposits (ours are unimportant in comparison to them) an inexhaustible mine of fossil wonders, and be able to rebuild in its integrity the transition age, from the Cretaceous to the Tertiary, a serial link destroyed in Europe by a succession of blanks.

Nevertheless in Provence even, and quite near Aix, we have a small agglomeration of what is known under the name of Lignitic of Felveau, which my friend Matheron has determined as the equivalent of the fresh-water upper Cretaceous formation (Santonienne) which passes by degrees in its upper part to strata incontestably of Tertiary age. Regretfully, however, these intermediate layers which would be most interesting to know well are very barren of fossils, while the lignitic themselves have a lacustrine fluviatile fauna, and also brackish deposits extremely

rich in fossils. At a much higher level we have the gypsum of Aix, which you probably know by name at least.

I beg you will accept my highest regard and sincere devotedness.— COUNT GASTON DE SAPORTA, Aix in Provence.

MICROSCOPY.[1]

MICROSCOPICAL STRUCTURE OF AMBER.—A paper on this subject, contributed jointly by H. C. Sorby and P. J. Butler, to the Royal Microscopical Society, furnishes many interesting observations and reflections. Scattered irregularly through the masses of amber are a vast number of minute cavities, usually $\frac{1}{2000}$ to $\frac{1}{30000}$ of an inch in diameter, though some are as large as $\frac{1}{1000}$, and others probably as small as $\frac{1}{100000}$ of an inch. Though very numerous in the clouded portions of the amber, these cavities are nearly wanting in the very transparent specimens, and therefore cannot be considered a necessary result of the changes which occurred during the hardening of the balsam or resin from which the amber must have been formed. They are usually round, the shape which would be naturally assumed by drops of water or bubbles of air confined in a stiff liquid, differing in this respect from the cavities in crystals which are often spaces left vacant during the formation of the crystal, and are bounded by crystalline planes having direct relation to the form and structure of the crystal itself. The cavities in amber, however, are sometimes elongated or otherwise changed by internal movements in the resinous mass before it became hard and brittle. Some of these cavities are filled with a liquid, probably water, which differs so slightly from the amber in refractive power, that these cavities are transparent throughout a large portion of their area, the circumference being marked by a narrow, dark line. Other cavities contain gas, constituting true air bubbles, whose dark outline constitutes at least one third of their diameter, leaving a comparatively small bright spot in the centre. Still other cavities contain liquid with an inclosed air bubble; while some of the fluid cavities only seem to contain one or more air bubbles from the appearance through them of images of one or more smaller cavities beneath. Most of the cavities originally contained water, which was eliminated during the process of change from a soft balsam to a hard resin, but subsequently the water escaped from many of the cavities leaving air cavities instead, which are not only especially abundant near the natural surface of pieces of amber, but may also be found very generally close to the surfaces of sections which have been prepared and mounted for microscopical use. A comparatively rare form of cavity, and characteristic of amber, is balloon shaped, the portion representing the car being nearly always filled with water and the upper part of the balloon with air. This may have been originally a round fluid cavity, from which the gas was allowed to escape into the still plastic, surrounding

[1] Conducted by DR. R. H. WARD, Troy, N. Y.

mass by reason of diminished pressure, shrinkage in the mass having continued to occur after the external portion had become hardened into an immovable crust; a theory which is confirmed by the effects on polarized light, the central portions of the mass having no power to depolarize the light, while the marginal portions depolarize it in such manner as to indicate a strain caused by pressure in the line of the circumference and not in the line of the radius. Similarly, the black crosses seen under polarized light in certain portions of the amber, having as nuclei either air bubbles or minute solid angular bodies of a sand-like appearance, are of a character to indicate not increased but diminished pressure from within, not an expansion of the contents, or a contraction of the surrounding material upon it as is the case with minute crystals inclosed in diamonds, but a shrinkage of the contents of relatively hardened layers surrounding the bubbles or granules.

False Light Excluder. — E. Gundlach of Rochester, N. Y., mounts his new two-inch lenses with a brass tube $\frac{5}{8}$ inch long projecting below the front surface of the objective and having a perforated diaphragm at its lower end. This cuts off much of the stray light that would otherwise enter, and still leaves $1\frac{1}{8}$ inch of working focus.

New Objects. — The very interesting preparations of recent and fossil diatoms, by Dr. R. S. Warren, of Waltham, Mass., can now be obtained from Mr. Charles Stodder, of Boston. Many of the slides, especially those from Savannah and the Isles of Shoals, contain new or rare forms.

Charles Zentmayer, of Philadelphia, son of the well-known Joseph Zentmayer of the same city, is preparing double-stained vegetable tissues with great success. The coloring is excellently distributed and the cell peculiarity well preserved.

Identity of the Red Blood Corpuscles in Different Human Races. — Dr. J. G. Richardson, of Philadelphia, well known as a leading advocate of the possibility of distinguishing by measurement the blood corpuscles of man from those of many of the familiar domestic animals, has recently extended his researches to the blood corpuscles of the different races of mankind, with a view to determine by comparative study whether they are identical or not. Taking advantage of the opportunity afforded by the International Exhibition at Philadelphia, he obtained, in some cases with considerable difficulty, permission to secure specimens of their blood from a considerable number of the members and *attachés* of the foreign commissions present at the Centennial. A finger having been suddenly pricked with a cataract needle, the top of the exuding drop of blood was touched to the centre of a glass slide, and the small drop thus obtained was spread by means of the edge of another slide, after Dr. Christopher Johnson's excellent method. In the dried film the corpuscles were measured by a cobweb micrometer whose reading, as actually employed in this work with a $\frac{1}{25}$ immersion objective of

a power of 1800, was determined by comparison with a standard of known accuracy. Only the circular disks were measured, in the thinnest part of the film, where they were least distorted in drying and most nearly in a natural condition, this method being believed to give the dimensions of the normal cell-elements more satisfactorily than can be accomplished by taking the average of the different diameters of the distorted corpuscles. So slight a deviation from a circular form as an oval having diameters of 1–3030 and 1–2857 was easily recognized, and such individuals were discarded, but all isolated circular red disks which appeared in the field were measured without selection. The measurements were recorded in fractions of an inch. Of 1400 corpuscles examined, six had a measurement of 1–4000, ten a measurement of 1–2777, and the remainder were between these two extremes. Eighty-three per cent of the whole measured from 1–3448 to 1–3030, and consequently appeared of about the same size under a power of 200. The slightly smaller averages of the Italian, Swedish, and Norwegian specimens are believed to be too small for a decisive indication of a natural difference, and the general result is believed by the author to indicate the essential identity of the different specimens studied. We have prepared the following table, which embodies all the data published in Dr. Richardson's paper in the *American Journal of Medical Science* for January, 1877: —

Nationality of Subject.	Age of Subject.	Number of Corpuscles Measured.	Average Diameter of Corpuscles.	Maximum Diameter of Corpuscles.	Minimum Diameter of Corpuscles.	Percentage of Corpuscles less than 1–3448 in Diameter.	Percentage of Corpuscles between 1–3448 and 1–3030 in Diameter.	Percentage of Corpuscles more than 1–3030 in Diameter.
Japanese	..	100	1–3212	1–2777	1–3737	8	82	10
Spanish	30	100	1–3226	1–2777	1–3571	6	89	5
Belgian	38	100	1–3203	1–2777	1–3846	7	88	5
Swiss	40	100	1–3203	1–2857	1–4000	7	82	11
Turkish	29	100	1–3197	1–2777	1–3846	4	80	16
Danish	25	100	1–3257	1–2857	1–4000	12	82	6
Russian	27	100	1–3190	1–2857	1–3571	2	91	7
Norwegian	35	100	1–3252	1–2857	1–4000	10	86	4
Swedish	33	100	1–3254	1–2777	1–3737	13	82	5
Italian	35	100	1–3272	1–2777	1–4000	10	83	7
French	67	100	1–3239	1–2777	1–3737	12	80	8
Dark mulatto, born in U. S.	52	100	1–3229	1–2857	1–3856	11	83	6
Cherokee Indian, born in U. S.	48	100	1–3215	1–2857	1–4000	10	83	7
English parentage, born in U. S.	40	100	1–3191	1–2777	1–3846	6	85	9
Total	..	1400	1–3224	1–2777	1–4000	8	83	9

SCIENTIFIC NEWS.

— Dr. Juan Gundlach, of Cuba, and Herr Leopold Krug, of Porto Rico recently spent a year in exploring the fauna of the latter island, and obtained as the result of their exertions 4 species of bats, 3 of mice, 152 birds, 22 or 23 reptiles, many fresh-water fishes, 18[illegible] marine gasteropods, 62 marine bivalves, 72 land or fresh-water Mollusca, 52 Crustacea, more than 800 Lepidoptera, including micros, 483 Coleoptera, 75 Orthoptera, 189 Hemiptera, 43 Neuroptera, 166 Hymenoptera, and 162 Diptera. They also secured some arachnids and many myriapods, as well as radiates. Herr Krug is now in Berlin with the whole collection, which will be worked up by specialists, and a general report of the whole will eventually be published.

— Among the recent publications or reprints of Messrs. D. Appleton & Co., which will be of value to naturalists as well as physicists, are the following: Arnott's Elements of Physics or Natural Philosophy. Seventh edition, edited by Alexander Bain and A. S. Taylor. New York, 1877. Prof. E. L. Youman's Class Book of Chemistry on the Basis of the New System, rewritten and revised, with many new illustrations. New York, 1876. W. G. Spencer's Inventional Geometry gives "a series of problems intended to familiarize the pupil with geometrical conceptions, and to exercise his inventive faculty." It is written by the father of Herbert Spencer. Helmholtz's Popular Lectures on Scientific Subjects have been read with the greatest interest by scientists whether biological, geological, or physical in their leanings. One's education as a naturalist will be scarcely complete until he has read the lecture On the Relation of Natural Science to Science in General, and that On the Aim and Progress of Physical Science.

PROCEEDINGS OF SOCIETIES.

Cambridge Entomological Club. — December 8, 1876. Mr. Dimmock said that in consideration of the assertion sometimes made, that female canker-moths [Anisopteryx] are occasionally carried up into trees by the males flying while in connection with them, he had made some measurements of the relative weight of the males and females, and had found that the females weigh on the average about thirty times as much as the males. These being weak-winged and slow-flying insects, it seems very improbable that the males would be able to support the weight of the females in flying through the air.

Mr. S. H. Scudder exhibited a specimen of Myrmecophila, found by Mr. H. K. Morrison in Georgia this year, this being the first specimen the capture of which in this country was authenticated. Mr. Morrison had been unable to recollect under what circumstances the specimen was collected. Dr. T. W. Harris had stated that on one occasion he found

certain soft-bodied crickets upon cucumber vines and had conjectured that they were specimens of a Myrmecophila, but there had been no confirmation of his supposition. Mr. Scudder made some further statements in regard to the Monoplistidæ, the family to which this genus belongs, and exhibited a specimen of the European species of Myrmecophila, which is found in ants' nests.

Mr. S. H. Scudder said that he was working upon a collection of fossil ants from South Park, Colorado. Heer, in his work on the fossil insects of Œningen and Radoboj, had found that most of the fossil ants discovered were winged females. It seemed reasonable that this should be so, as the winged insects were the most likely to fall into the water and be drowned, and especially the females who are much more heavy-bodied than the males. Mr. Scudder had found about forty species of ants in this collection, mostly belonging to the Formicidæ, but also to the Myrmicidæ and Poneridæ. Most of the specimens were winged females. In amber fossils most of the specimens of ants are workers.

Academy of Natural Sciences, Philadelphia. — December 19th. Mr. Meehan detailed some experiments of his own on the growth of wood, by disbarking cherry-trees in June, and watching the process. The outer series of wood cells of last year formed generating tissue from which the new season's wood was formed, the outermost layer of the new growth forming the new bark, which had no generative power. A few of these bark cells, in some instances, remained imperfect wood cells, with generative power, and from these nuclei the future protuberance was formed, the tissue continuing to reproduce and form a new layer annually as in ordinary wood growth. Instances of various kinds of growth of this character were described. The varying vital power of cells in different parts of the structure, as detailed in his remarks, were then taken to illustrate the various forms of eccentricity often noted in wood growth, as also the occasional appearance of bark within the structure and between the annual layers of wood.

SCIENTIFIC SERIALS.[1]

The Geographical Magazine. — January, 1877. The Arctic Expedition, the Results, the Outbreak of Scurvy, the Welcome Home. International Exploration of Africa; the Share of Portugal. The Abbé Desgodius on Tibet.

Annals and Magazine of Natural History. — December, 1876. New and Peculiar Mollusca of the Kellia, Lucina, Cyprina, and Corbula Families procured in the "Valorous" Expedition, by J. E. Jeffreys. List of Mollusca collected by the Rev. A. E. Eaton, at Spitzbergen, etc., determined by J. G. Jeffreys. Anatomical and Morphological Researches

[1] The articles enumerated under this head will be for the most part selected.

on the Nervous System of Hymenopterous Insects, by E. Brandt (abstract by the editors).

Appalachian Mountain Club. — January 10th. A paper on the Flowering Plants of the White Mountains was read by Mr. J. H. Huntington.

Academy of Sciences. — New York, January 22d. The following papers were read: The Occurrence of Microlite in Massachusetts and North Carolina, by A. A. Julien; The Fossil Fishes of the Connecticut Valley, New Jersey, and Virginia, by Dr. J. S. Newberry; The Quartzes, Micas, and Feldspars of New York City and Vicinity.

Boston Society of Natural History. — January 3d. Mr. J. H. Emerton made a comparison of the spiders of North America and Europe.

January 17th. — Papers were read by Dr. D. Hunt on The Closure of the first Branchial Cleft in the Mammalia; by Dr. T. M. Brewer On the Peculiar Parasitic Habits of *Molothrus Bonariensis* of South America; and by Mr. J. H. Huntington on a New Machine for making Rock-Sections.

Monthly Microscopical Journal. — January, 1877. On *Navicula crassinervis*, *Frustulia Saxionica*, and *Navicula rhomboides*, as Test-Objects, by W. H. Dallinger. A Stage Incubator, by H. A. Reeves. Notes on Pollen, by W. G. Smith.

Quarterly Journal of Microscopical Science. — January 1877. On the Coloring Matters of Various Animals, and especially of Deep-Sea Forms dredged by H. M. S. Challenger, by H. N. Moseley. On *Stylochus Pelagicus*, a New Species of Pelagic Planarian, with Notes on other Pelagic Species, on the Larval Forms of Thysanzoon, and of a Gymnosomatous Pteropod, by H. N. Moseley. Note on a Method of preparing the Cornea, by Dr. E. Klein. Schiefferdecker's Microtome, by P. Kidd. The Minute Structure of the Gills of Lamellibranch Mollusca, by R. H. Peck. Résumé of Recent Contributions to our Knowledge of Freshwater Rhizopoda. Part III. Heliozoa and Monothalamia, compiled by William Archer. E. Schultze and Herting's Discovery of Nuclei in Foraminifera, by the Editors.

The Geological Magazine. — January, 1877. On Evolution in Geology, by W. J. Sollas. The Supposed Glacial Origin of Carboniferous Terraces, by J. R. Dakyns.

The Popular Science Review. — January, 1877. Nursing Echinoderms. (Describing Viviparous forms.)

Erratum. — Page 122, tenth line from bottom, for *Peruvian* read *Permian*.